

MASTER

BLACKSTONE RIVER BASIN
LEICESTER, MASSACHUSETTS

LYNDE BROOK RESERVOIR DAM

MA 00990

EAST DIKE

MA 01290

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

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DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS. 02154

MAY 1980

UNCLASSIFIED

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number) DAMS, INSPECTION, DAM SAFETY, Blackstone River Basin Leicester, Massachusetts Lynde Brook		
20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The dam is an earth embankment about 58 ft. high and 500 ft. long, and has a core masonry wall. The dam is judged to be in generally good condition, however the overall rating must be fair due to spillway inadequacy. There is minor seepage at two locations along the downstream toe.		



DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
424 TRAPELO ROAD
WALTHAM, MASSACHUSETTS 02254

REPLY TO
ATTENTION OF:

NEDED-E

NOV 14 1980

Honorable Edward J. King
Governor of the Commonwealth of
Massachusetts
State House
Boston, Massachusetts

Dear Governor King:

Inclosed is a copy of the Lynde Brook Reservoir Dam (MA-00990-Dam) and (MA-01290-East Dike) Phase I Inspection Report, which was prepared under the National Program for Inspection of Non-Federal Dams. The report is based upon a visual inspection, a review of past performance, and a preliminary hydrological analysis. A brief assessment is included at the beginning of the report.

The preliminary hydrologic analysis has indicated that the spillway capacity for the Lynde Brook Reservoir Dam and East Dike would likely be exceeded by floods greater than 13 percent of the Probable Maximum Flood (PMF), the test flood for spillway adequacy. Our screening criteria specifies that a dam of this class which does not have sufficient spillway capacity to discharge fifty percent of the PMF, should be adjudged as having a seriously inadequate spillway and the dam assessed as unsafe, non-emergency, until more detailed studies prove otherwise or corrective measures are completed.

The term "unsafe" applied to a dam because of an inadequate spillway does not indicate the same degree of emergency as that term would if applied because of structural deficiency. It does indicate, however, that a severe storm may cause overtopping and possible failure of the dam, with significant damage and potential loss of life downstream.

It is recommended that within twelve months from the date of this report the owner of the dam engage the services of a professional or consulting engineer to determine by more sophisticated methods and procedures the magnitude of the spillway deficiency. Based on this determination, appropriate remedial mitigating measures should be designed and completed within 24 months of this date of notification. In the interim a detailed emergency operation plan and warning system should be promptly developed. During periods of unusually heavy precipitation, round-the-clock surveillance should be provided.

NOV 14 1980

NEDED-E

Honorable Edward J. King

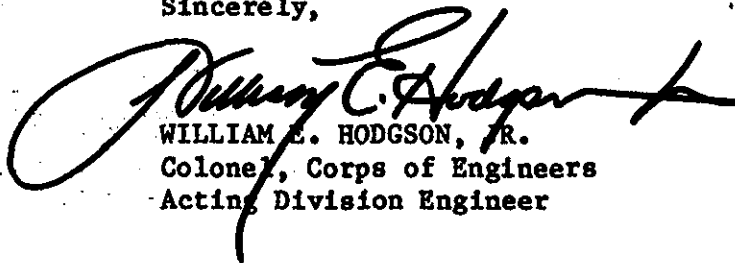
I have approved the report and support the findings and recommendations described in Section 7, with qualifications as noted above. I request that you keep me informed of the actions taken to implement these recommendations since this follow-up is an important part of the non-Federal Dam Inspection Program.

A copy of this report has been forwarded to the Department of Environmental Quality Engineering, the cooperating agency for the Commonwealth of Massachusetts. This report has also been furnished to the owner of the project, City of Worcester, Mass.

Copies of this report will be made available to the public, upon request to this office, under the Freedom of Information Act, thirty days from the date of this letter.

I wish to take this opportunity to thank you and the Department of Environmental Quality Engineering for the cooperation extended in carrying out this program.

Sincerely,

A large, stylized handwritten signature in black ink, appearing to read "William E. Hodgson, Jr.", is written over the typed name and title.

WILLIAM E. HODGSON, JR.
Colonel, Corps of Engineers
Acting Division Engineer

LYNDE BROOK RESERVOIR DAM

MA 00990

EAST DIKE

MA 01290

BLACKSTONE RIVER BASIN
LEICESTER, MASSACHUSETTS

PHASE I INSPECTION REPORT
NATIONAL DAM INSPECTION PROGRAM

NATIONAL DAM INSPECTION PROGRAM
PHASE I INSPECTION REPORT

Identification No.: MA 00990
Name of Dam: Lynde Brook Reservoir Dam
Town: Leicester
County and State: Worcester County, Massachusetts
Stream: Lynde Brook
Date of Inspection: 16 April 1980

BRIEF ASSESSMENT

Lynde Brook Reservoir Dam, constructed in 1876, is an earth embankment about 58 ft. high, 500 ft. long and has a masonry core wall. The left abutment of the dam appears to be a manmade promontory. This promontory also serves as the right abutment of a 1,050 ft. long, 14.5 ft. high dike located east of the dam. The dike also has a masonry core wall. The upstream slopes of both embankments are random rock riprap. The crest and downstream slopes are grass covered. There are two outlet facilities for the reservoir; a submerged intake tower at the dam and a gate house at the dike. The reservoir can be drawn down by means of a 24 in. dia. blowoff pipe at the main dam.

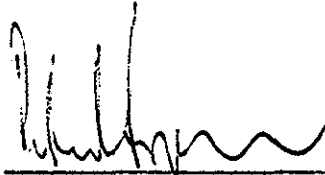
The reservoir is about 4,700 ft. long and the surface area of the pond at spillway crest is about 124 acres. The drainage area above the dam is about 2.80 sq. mi. (1,795 acres), the maximum storage to top of dam is about 2,737 acre-ft., and the height of the dam is about 58 ft. Based on height and storage, the size classification is intermediate. A breach of the dam would damage 21 homes, seven commercial establishments, three mill complexes, a state route, several other roadways and potentially cause the loss of more than a few lives. Therefore, the dam has been classified as having a high hazard potential. Based upon the guidelines, the recommended test flood is a full PMF (4,970 cfs).

The routed test flood outflow (4,350 cfs) would overtop the dam by about 1 ft. The spillway can pass about 560 cfs or about 13 percent of the routed test flood outflow without overtopping the dam.

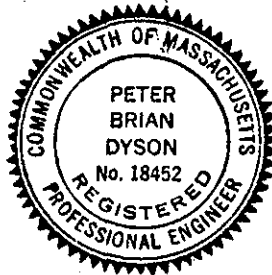
The dam is judged to be in generally good condition structurally, however the overall rating must be fair due to spillway inadequacy. There is minor seepage at two locations along the downstream toe. The dike is also judged to be in good condition. There was no evidence of seepage along the downstream slope of the dike. Both the dam and dike, as well as the outlet facilities, are kept in good working condition.

Within one year after receipt of this Phase I Inspection Report, the owner, the City of Worcester, should retain the services of a registered professional engineer and implement the results of his evaluation of the following: (1) a detailed hydrologic-hydraulic investigation to assess further the potential for overtopping and the adequacy of the spillway; (2) a yearly evaluation of the seepage at the downstream toe of the dam; (3) investigate possible relocation of gate controls to upstream side of embankment; and, (4) whether spillway discharge channel modifications are required to forestall possible overtopping of the walls.

The owner should also implement the following operating and maintenance measures: (1) develop a formal surveillance and downstream emergency warning plan including round-the-clock monitoring during periods of heavy precipitation; (2) institute procedures for an annual technical inspection of the dam and its appurtenant structures, including the minor seepage; and, (3) prepare a copy of the dam outlet control plan.



Peter B. Dyson
Project Manager



This Phase I Inspection Report on Lynde Brook Reservoir Dam & East Dike has been reviewed by the undersigned Review Board members. In our opinion, the reported findings, conclusions, and recommendations are consistent with the Recommended Guidelines for Safety Inspection of Dams, and with good engineering judgment and practice, and is hereby submitted for approval.

Carney M. Terzian

CARNEY M. TERZIAN, MEMBER
Design Branch
Engineering Division

Richard J. DiBuono

RICHARD DIBUONO, MEMBER
Water Control Branch
Engineering Division

Aramast Mahtesian

ARAMAST MAHTESIAN, CHAIRMAN
Geotechnical Engineering Branch
Engineering Division

APPROVAL RECOMMENDED:

Joe B. Fryar
JOE B. FRYAR
Chief, Engineering Division

PREFACE

This report is prepared under guidance contained in the Recommended Guidelines for Safety Inspection of Dams, for Phase I Investigations. Copies of these guidelines may be obtained from the Office of Chief of Engineers, Washington, D.C. 20314. The purpose of a Phase I Investigation is to identify expeditiously those dams which may pose hazards to human life or property. The assessment of the general condition of the dam is based upon available data and visual inspections. Detailed investigation, and analyses involving topographic mapping, sub-surface investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

In reviewing this report, it should be realized that the reported condition of the dam is based on observations of field conditions at the time of inspection along with data available to the inspection team. In cases where the reservoir was lowered or drained prior to inspection, such action, while improving the stability and safety of the dam, removes the normal load on the structure and may obscure certain conditions which might otherwise be detectable if inspected under the normal operating environment of the structure.

It is important to note that the condition of a dam depends on numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be any chance that unsafe conditions be detected.

Phase I inspections are not intended to provide detailed hydrologic and hydraulic analyses. In accordance with the established Guidelines, the Spillway Test Flood is based on the estimated "Probable Maximum Flood" for the region (greatest reasonably possible storm runoff), or fractions thereof. Because of the magnitude and rarity of such a storm event, a finding that a spillway will not pass the test flood should not be interpreted as necessarily posing a highly inadequate condition. The test flood provides a measure of relative spillway capacity and serves as an aide in determining the need for more detailed hydrologic and hydraulic studies, considering the size of the dam, its general condition and the downstream damage potential.

The Phase I Investigation does not include an assessment of the need for fences, gates, no-trespassing signs, repairs to existing fences and railings and other items which may be needed to minimize trespass and provide greater security for the facility and safety to the public. An evaluation of the project for compliance with OSHA rules and regulations is also excluded.

TABLE OF CONTENTS

<u>Section</u>	<u>Page</u>
Letter of Transmittal	
Brief Assessment	
Review Board Page	
Preface	i
Table of Contents	ii
Overview Photo	v
Location Map	vi

REPORT

1. PROJECT INFORMATION

1.1 General	1
a. Authority	1
b. Purpose of Inspection	1
1.2 Description of Project	1
a. Location	1
b. Description of Dam and Appurtenances	1
c. Size Classification	2
d. Hazard Classification	2
e. Ownership	3
f. Operator	3
g. Purpose of Dam	3
h. Design and Construction History	3
i. Normal Operational Procedure	3
1.3 Pertinent Data	3

2. ENGINEERING DATA

2.1 Design Data	7
2.2 Construction Data	7
2.3 Operation Data	7
2.4 Evaluation of Data	7

<u>Section</u>	<u>Page</u>
3. VISUAL INSPECTION	
3.1 Findings	8
a. General	8
b. Dam	8
c. Appurtenant Structures	8
d. Reservoir Area	9
e. Downstream Channel	9
3.2 Evaluation	9
4. OPERATIONAL AND MAINTENANCE PROCEDURES	
4.1 Operational Procedures	10
a. General	10
b. Description of any Warning System in Effect	10
4.2 Maintenance Procedures	10
a. General	10
b. Operating Facilities	10
4.3 Evaluation	10
5. EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES	
5.1 General	11
5.2 Design Data	11
5.3 Experience Data	11
5.4 Test Flood Analysis	11
5.5 Dam Failure Analysis	12
6. EVALUATION OF STRUCTURAL STABILITY	
6.1 Visual Observation	14
6.2 Design and Construction Data	14
6.3 Post-Construction Changes	14
6.4 Seismic Stability	14

<u>Section</u>	<u>Page</u>
7. ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES	
7.1 Dam Assessment	15
a. Condition	15
b. Adequacy of Information	15
c. Urgency	15
7.2 Recommendations	15
7.3 Remedial Measures	15
a. Operation and Maintenance Procedures	15
7.4 Alternatives	16

APPENDIXES

APPENDIX A - INSPECTION CHECKLIST

APPENDIX B - ENGINEERING DATA

APPENDIX C - PHOTOGRAPHS

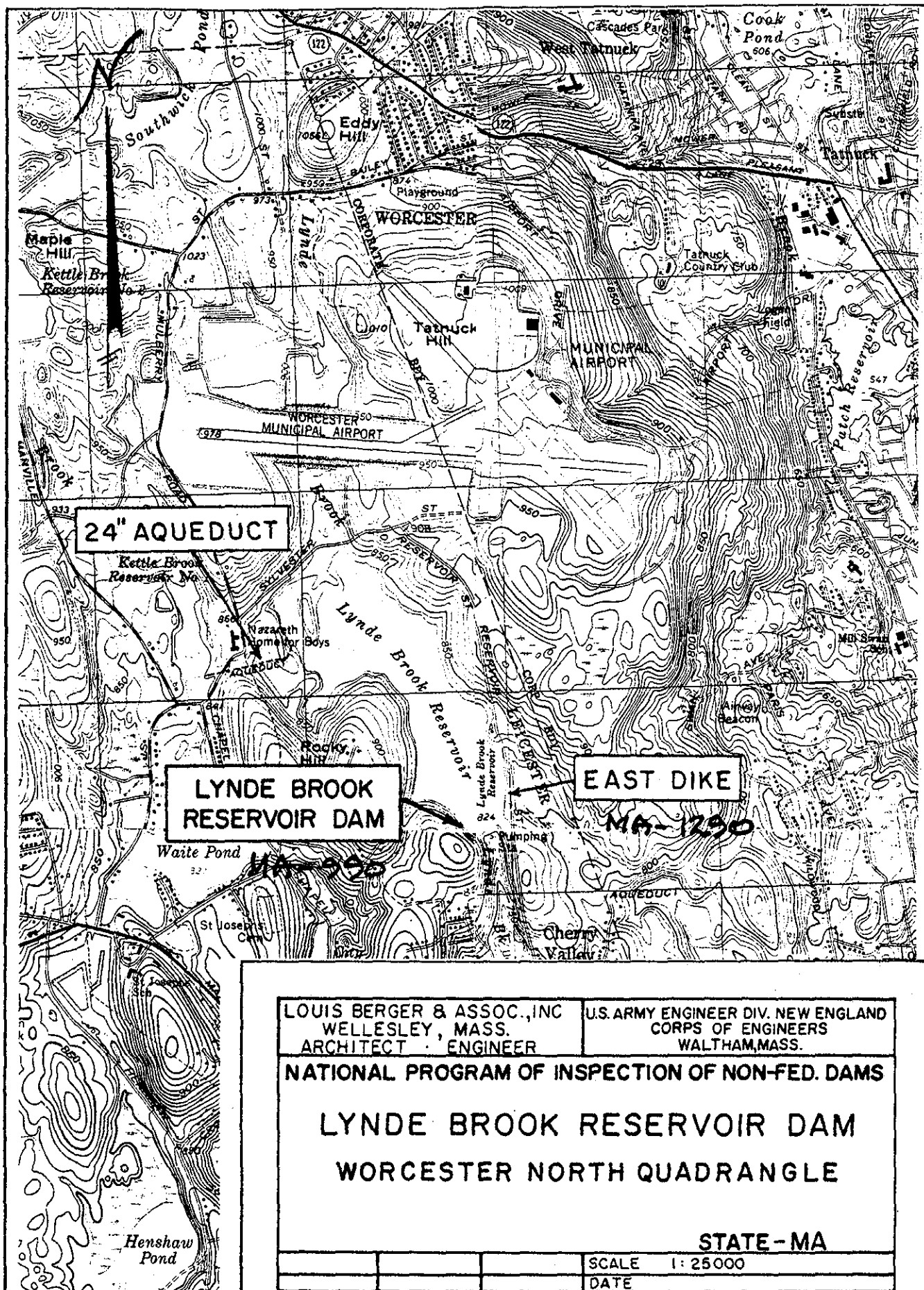
APPENDIX D - HYDROLOGIC AND HYDRAULIC COMPUTATIONS

APPENDIX E - INFORMATION AS CONTAINED IN THE NATIONAL
INVENTORY OF DAMS

LYNDE BROOK RESERVOIR DAM



OVERVIEW OF DAM FROM RIGHT ABUTMENT



LOUIS BERGER & ASSOC., INC
WELLESLEY, MASS.
ARCHITECT ENGINEER

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LYNDE BROOK RESERVOIR DAM WORCESTER NORTH QUADRANGLE

STATE - MA

SCALE 1: 25000

DATE

PHASE I INSPECTION REPORT

LYNDE BROOK RESERVOIR DAM MA 00990

SECTION 1 - PROJECT INFORMATION

1.1 General

a. Authority. Public Law 92-367, August 8, 1972, authorized the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspection throughout the United States. The New England Division of the Corps of Engineers has been assigned the responsibility of supervising the inspection of dams within the New England Region. Louis Berger & Associates, Inc. has been retained by the New England Division to inspect and report on selected dams in the State of Massachusetts. Authorization and notice to proceed was issued to Louis Berger & Associates, Inc. under a letter of 28 March 1980 from William E. Hodgson, Jr., Colonel, Corps of Engineers. Contract No. DACW33-80-C-0043 has been assigned by the Corps of Engineers for this work.

b. Purpose of Inspection

(1) Perform technical inspection and evaluation of non-Federal dams to identify conditions which threaten the public safety and thus permit correction in a timely manner by non-Federal interests.

(2) Encourage and assist the States to initiate quickly effective dam safety programs for non-Federal dams.

(3) Update, verify and complete the National Inventory of Dams.

1.2 Description of Project

a. Location. Lynde Brook Reservoir Dam is located in Worcester County in the Town of Leicester in south-central Massachusetts. The reservoir is situated on Lynde Brook approximately 0.7 miles above Smiths Pond. From this pond issues Kettle Brook, which joins the Middle Blackstone River at a point about 6.8 miles below the dam. The dam is shown on U.S.G.S. Quadrangle, Worcester North, Massachusetts, with coordinates approximately at N 42° 15' 07", W 71° 52' 24".

b. Description of Dam and Appurtenances.

(1) Description of Dam. Lynde Brook Reservoir Dam is an earth embankment about 58 ft. high and about 500 ft. long with a masonry core wall. The elevation at the top of the core wall is unknown. The dam was constructed in 1876. The dam has a crest width of about 50 ft. and a downstream slope of about 2½ horizontal to 1 vertical. Both the crest and downstream slope are sodded. The upstream slope is of random rock riprap.

The left abutment of the dam is a promontory, which appears to be man-made, between the dam and a dike located east of the dam. The reservoir rim along the left abutment is random rock riprap and the crest of the abutment is sodded. A paved access road to the reservoir outlet facilities below the main dam is located across the crest of the abutment about 300 ft. from the reservoir rim.

Lynde Brook Reservoir is connected to a series of other reservoirs via a 24 in. dia. aqueduct (see page IV). The facility is used to store excess runoff from the other reservoirs.

(2) Description of East Dike. A 1,050 ft. long and about 14.5 ft. high dike connects the left abutment of the dam with the northern reservoir rim. This dike has a crest width of about 42 ft. and a downstream slope of about 1 2/3 horizontal to 1 vertical, both of which are sodded. The upstream slope is of random rock riprap. The drawings in Appendix B indicate that the dike has a masonry core wall, however, the elevation is unknown.

(3) Spillway. The spillway for Lynde Brook Reservoir Dam is located at the right abutment of the dam. It has a crest length of 28.8 ft. between the grouted ashlar masonry training walls. An 8 in. high steel angle iron serves as the fixed crest. The top of dam is 3.5 ft. above the spillway crest. Both the upstream approach channel and downstream discharge channel are paved with concrete grouted riprap. The downstream channel converges from about 28.8 ft. to about 16 ft. just downstream of the crest. It has 2.5 ft. high rubble masonry training walls and a slope of 7 horizontal to 1 vertical. At the end of the 345 ft. long channel there is heavy rock riprap.

(4) Outlets. There are two outlet facilities for Lynde Brook Reservoir. A submerged intake tower is located about 200 ft. left of the right abutment of the dam and about 50 ft. upstream of the crest of the dam. The submerged intake tower has three 24 in. dia. cast iron outlet pipes with the invert located about 42 ft. below the top of dam or about elevation 785(+). These three pipes are carried under the dam in a stone box culvert and enter into a gate house located at the downstream toe of the dam. The level of the top of the inlet tower is unknown. In the gate house there are manual gate valves and stems for controlling outflows. The right and center pipes provide water for the municipal water supply system and cannot be used for reservoir drawdown. A chlorination house located about 75 ft. downstream of the gate house provides chlorine treatment to the discharge from these two outlet pipes. The left outlet pipe is used as a mud pipe or blowoff pipe. It outlets about 200 ft. downstream of the gate house through a rubble masonry headwall. All gates were reported to be in operating condition.

A gate house is located about 180 ft. right of the left abutment of the east dike and is accessed by an approximately 35 ft. long catwalk from the crest of the dike. There is only one outlet from the gate house at the dike. A 30 in. dia. pipe carries flows from the gate house under the dike into the municipal water supply system. Outflows are controlled by a manual slide gate reported to be in operating condition. The invert is estimated to be at about elevation 805 (±).

c. Size Classification. Lynde Brook Reservoir Dam has a hydraulic height of about 58 ft. above downstream river level, and impounds a normal storage of about 2,300 acre-ft. to spillway crest level and a maximum of about 2,737 acre-ft. to top of dam. In accordance with the size and capacity criteria given in Recommended Guidelines for Safety Inspection of Dams, the project falls into the intermediate category on the basis of height and storage and is therefore classified accordingly.

d. Hazard Classification. A breach failure analysis was performed in the event of either a dam or dike failure at Lynde Brook Reservoir. In the initial impact area below the dam it is estimated that about 20 homes, 7 commercial establishments and 3 mill complexes would be severely flooded by the breach discharge. In the initial impact area below the dike it is estimated that between

50 and 70 homes, 6 commercial establishments, a school and a church would be severely flooded by the breach discharge. Depths of flooding would range between 1 and 9 ft.

In accordance with the Recommended Guidelines for Safety Inspection of Dams, Lynde Brook Reservoir has therefore been classified as having a high hazard potential, since failure of either the dam or dike would cause serious damage to homes, industries, commercial establishments and highways, with the potential for the loss of more than a few lives.

e. Ownership. Lynde Brook Reservoir Dam is owned by the City of Worcester, Mass.

f. Operator. The operator of the dam is Mr. Ken Starbard, Superintendent, Worcester Water Dept., Worcester, Mass. Telephone (413)829-4811.

g. Purpose of Dam. Lynde Brook Reservoir Dam is operated in conjunction with other water storage facilities for providing municipal water supplies to the City of Worcester.

h. Design and Construction History. Lynde Brook Reservoir and Dam was constructed in 1876. A wood and earth dam said to have been constructed by local Indians previously existed at the site and its submerged remnants are located just upstream of the present dam.

The present dam was designed by Wm. J. McAlpine, Consulting Engineer. Copies of two of the original plans of the dam and dike can be found in Appendix B. There is also a copy of a third plan dated 1897 showing a cross-section through the dike and gate house. There also exists a plan of the outlet facilities of the dam, downstream gate house and chlorination house piping system. This plan is securely fastened to an inside wall of the chlorination house. A sketch copy of it is included in Appendix B.

i. Normal Operating Procedure. There are no written operating procedures for the facility. The reservoir is utilized as a storage facility for excess runoffs from other reservoirs. It is connected to Kettle Brook Reservoir No. 1 immediately upstream via a 24 in. dia. gravity feed conduit (see Location Map, page IV). The only operating devices are the gates and valves associated with the gate house structures. The grass on the crests and downstream slopes is cut periodically and the spillway training walls and chute are repaired as necessary.

1.3 Pertinent Data

a. Drainage Area. The drainage area contributing to Lynde Brook Reservoir encompasses a total of about 2.80 sq. mi. (1,795 acres), of which 124 acres are occupied by the reservoir. The longest circuitous stream course leading to the dam is about 3.71 miles long with an elevation difference of about 391 ft., or at a slope of about 105 ft. per mile. The drainage area has a length of about 3.5 miles and has an average width of about 0.9 miles. The basin consists of both open fields and forested areas with housing developments located in the very upper reaches of the drainage area. Southwick Pond is also situated in the upper reaches of the drainage area and nearly all of the Worcester Municipal Airport is located near the midpoint of the area. Kettle Brook Reservoir No. 1, the last in a series

of other reservoirs, is located in a drainage area that is immediately west of the Lynde Brook Pond Dam drainage area and an aqueduct that drains toward Lynde Brook Reservoir connects the two reservoirs.

b. Discharge at Damsite

(1) Outlet Works Conduit. Low level discharge from Lynde Brook Reservoir Dam is provided by a 24 in. dia. outlet pipe which extends from inside the reservoir to a gate house located on an earth bench at the toe of the dam. Flows in the pipe are regulated by a 24 in. gate valve in the gate house. Just downstream of the gate house the 24 in. dia. pipe makes a 90 degree bend to the left and a short distance from this point the 24 in. dia. line discharges into an old 48 in. square stone box conduit, which in turn discharges into a 40 in. dia. cast iron pipe emptying into Lynde Brook at the toe of the dam. At the gate house, the invert of the discharge pipe is about 785(±) ft. NGVD. The waste pipe would be capable of discharging about 61 cfs when the control valve was wide open and the reservoir water surface level was at the top of the dam. There are two other 24 in. dia. pipes and gate valves. These pipes however connect directly into the city water supply system and are not capable of low level withdrawal.

(2) Maximum Known Flood at Damsite. No records are available of flood inflows into Lynde Brook Reservoir, nor of spillway releases and surcharge heads during such inflows.

(3) Ungated Spillway Capacity at Top of Dam. The ungated spillway capacity at top of dam, elevation 827.35, is 560 cfs.

(4) Ungated Spillway Capacity at Test Flood Elevation. The ungated spillway capacity is 830 cfs at test flood elevation 828.3.

(5) Gated Spillway Capacity at Normal Pool Elevation. Not applicable.

(6) Gated Spillway Capacity at Test Flood Elevation. Not applicable.

(7) Total Spillway Capacity at Test Flood Elevation. The total spillway capacity at test flood elevation 828.3 is the same as (4) above, 830 cfs.

(8) Total Project Discharge at Top of Dam. The total project discharge at top of dam, elevation 827.35 ft., is 620 cfs.

(9) Total Project Discharge at Test Flood Elevation. The total project discharge at test flood is 4,350 cfs at elevation 828.3.

c. Elevation (Ft. N.G.V.D.)

(1) Streambed at toe of dam - 768.7±

(2) Bottom of cutoff - Unknown

(3) Maximum tailwater - Unknown

- (4) Recreation pool - Not Applicable
- (5) Full flood control pool - Not Applicable
- (6) Spillway crest - 824.0
- (7) Design surcharge (Original Design) - Unknown
- (8) Top of dam - 827.35
Top of dike - 827.35

(9) Test flood surcharge - 828.28

d. Reservoir (Length in Feet)

- (1) Normal pool - 4,700
- (2) Flood control pool - Not Applicable
- (3) Spillway crest pool - 4,700
- (4) Top of dam - 5,000
- (5) Test flood pool - 5,020

e. Storage (acre-feet)

- (1) Normal pool - 2,300
- (2) Flood control pool - Not Applicable
- (3) Spillway crest pool - 2,300
- (4) Top of dam - 2,737
- (5) Test flood pool - 2,870

f. Reservoir Surface (acres)

- (1) Normal pool - 124
- (2) Flood control pool - Not Applicable
- (3) Spillway crest 124
- (4) Top of dam - 138.5
- (5) Test flood pool - 142.5

g. Dam

- (1) Type - Earth Fill
- (2) Length - 500 ft.

Dike

Earth Fill
1,050 ft.

- | | |
|---|--|
| (3) Height - 57.7 ft. | 14.3 ft. |
| (4) Top Width - 50 ft. | 42 ft. |
| (5) Side Slopes - Downstream: $2\frac{1}{2}$ H
to 1 V. Upstream: Unknown | Downstream: $1\frac{2}{3}$ H. to 1 V.
Upstream: Unknown |
| (6) Zoning - Unknown | Unknown |
| (7) Impervious Core - Masonry Core Wall | Masonry Core Wall |
| (8) Cutoff - Unknown | Unknown |
| (9) Grout curtain - Unknown | Unknown |

h. Diversion and Regulating Tunnel - Not Applicable

i. Spillway

- (1) Type - Ashlar and rubble masonry with mortared joints, wasteway
- (2) Length of weir - 28.8 ft.
- (3) Crest elevation (with angle iron sill) - 824.0
- (4) Gates - None
- (5) U/S Channel - Reservoir
- (6) D/S Channel - Converging, 16 ft. wide rubble masonry, with mortared joints wasteway

j. Regulating Outlets

- (1) Invert - Elev. 784.3
- (2) Size - 24 in. circular, leading to 48 in. square, leading to 40 in. circular
- (3) Description - 24 in. cast iron pipe, leading to 48 in. sq. stone box culvert, leading to 40 in. cast iron pipe
- (4) Control Mechanism - Hand operated 24 in. inline gate valve.
- (5) There are two 24 in. dia. pipes from the dam gate house and a 30 in. dia. pipe from the dike gate house. All of these pipes feed into the closed water supply system for the City and therefore could not be used as a means of low level withdrawal.

SECTION 2 - ENGINEERING DATA

2.1 Design Data

The only data recovered concerning the design of the dam or appurtenances are the three plans found in Appendix B and a plan of the dam's outlet controls. A copy of this plan is not included in this report, as the only known copy is securely fastened to a wall inside the chlorinating house at the toe of the dam.

2.2 Construction Data

No records or correspondence regarding construction of the dam have been recovered.

2.3 Operation Data

No records or correspondence regarding past operation of the dam have been recovered. The only known operating records appear to be those of the chlorinating process and the recording of water levels. These records are maintained on a daily basis and are stored in the Worcester City Hall.

2.4 Evaluation of Data

a. Availability. Since no engineering data is available, it is not possible to make an assessment of the safety of the dam. The basis of the information presented in this report is principally the visual observations of the inspection team.

b. Adequacy. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgement.

c. Validity. Not applicable

SECTION 3 - VISUAL INSPECTION

3.1 Findings

a. General. The visual inspection of Lynde Brook Reservoir Dam took place on 16 April 1980. On that date the water level was just below the spillway crest and wave action was causing it to slightly lap over the crest. There was no evidence of major problems, but there is minor seepage at two locations downstream of the dam. The dam and dike are judged to be in good physical condition.

b. Dam. Lynde Brook Reservoir, an impoundment of Lynde Brook, consists of a dam, dike, spillway and outlet facilities. It provides storage for excess runoff from other reservoirs and is operated by its owner, the Worcester Water Dept., in conjunction with these other reservoirs as a municipal water supply facility.

The dam is an earth embankment with a masonry core wall. It is about 500 ft. long, 58 ft. high and has a crest width of about 50 ft. The crest and $2\frac{1}{2}$ horizontal to 1 vertical downstream slope are grass covered and well maintained. The upstream slope is of random rock riprap (see Appendix C, Photo Nos. 1 & 2). The left abutment is a promontory which appears to be man-made, between the dam and the dike located east of the dam (see Appendix B, Sketch Plan pg. B-1). The reservoir rim along the left abutment is random rock riprap and the crest of the abutment is sodded. A paved access road to reservoir outlet facilities is located across the crest of the abutment about 300 ft. from the reservoir rim. At the downstream toe of the junction of the dam and left abutment there is a minor seep estimated to be about 0.1 gpm. This seepage apparently passes under the access road, as there is a soft wet area to the left of the roadway (see Appendix C, Photo No. 7). There is another seepage area at the downstream toe of the dam about mid-dam and its flow is estimated to be less than 0.1 gpm. Both seeps are discharging clear colorless water (see Appendix C, Photo Nos. 5 & 6). In general the dam embankment is in good condition.

Dike. The dike is also an earth embankment with a masonry core wall. It is about 1,050 ft. long, 14.5 ft. high and has a crest width of about 42 ft. The crest and $1\frac{2}{3}$ horizontal to 1 vertical downstream slope are grass covered and well maintained. The upstream slope is of random rock riprap. At the time of the inspection there was no evidence of seepage along the dike. In general the dike is in excellent condition (see Appendix C, Photo Nos. 3 & 4).

c. Appurtenant Structures. The spillway for the facility is located at the right abutment of the dam. The spillway has a net crest length of 28.8 ft. between grouted ashlar masonry training walls. An 8 in. high steel angle iron serves as the fixed crest. The top of dam is 3.5 ft. above the spillway crest. The upstream approach apron is paved with concrete grouted riprap. The 7 horizontal to 1 vertical downstream spillway channel converges from the 28.8 ft. wide spillway crest to about 16 ft. just downstream of the crest. It has 2.5 ft. high mortared rubble masonry training walls and is paved with concrete grouted riprap. At the end of the 345 ft. long spillway chute there is heavy random rock riprap. The spillway is in generally good condition (see Appendix C, Photo Nos. 8, 9 & 10).

There are two outlet facilities for Lynde Brook Reservoir. A submerged intake tower is located about 200 ft. left of the right abutment of the dam and about 50 ft. upstream of the crest of the dam.

The top of the submerged intake tower is about 20 ft. below the top of dam. A steel grate serves as the top of the masonry structure. The inlets to two outlet pipes are at the bottom of the intake tower. A third outlet pipe originally also had its inlet at the bottom of the intake tower; however, this pipe has been extended through the intake tower and up into the reservoir to serve as a blowoff or mud pipe. All three outlet pipes are 24 in. dia. and have their inverts about 42 ft. below the top of dam.

These three outlet pipes are carried under the dam via a stone box culvert and emerge into a gate house located at the downstream toe of the dam. In the brick gate house there are manual gate valves and stems for controlling outflows. The right and center outlet pipes provide water for the municipal water supply system and cannot be used for reservoir drawdown. A brick chlorination house is located about 75 ft. downstream of the gate house. From here chlorine is added to the municipal water system. The left outlet pipe serves as the blowoff or mud pipe and outlets through a rubble masonry headwall about 200 ft. downstream of the gate house. All three outlet pipes are reported to be in good working condition (see Appendix C, Photo Nos. 11, 13 & 14).

A gate house is located about 180 ft. right of the left abutment of the east dike and is accessed by an approximately 35 ft. long catwalk from the crest of the dike. There is only one outlet pipe from the granite ashlar masonry gate house on the dike. This 30 in. dia. pipe is controlled by a slide gate in the gate house and flows into the municipal water supply system. The slide gate is reported to be in working condition (see Appendix C, Photo No. 12). The invert of the pipe is about 22 ft. below top of dike. In general the outlet facilities appear to be well maintained and in good working order.

d. Reservoir Area. The reservoir behind the dam and dike is an impoundment of Lynde Brook. The shoreline upstream of the dam and dike is in excellent condition with no evidence of slides, movements or distress. A 24 in. dia. aqueduct carries excess runoff from the Kettle Brook Reservoirs to Lynde Brook Reservoir.

e. Downstream Channel. At the downstream end of the spillway chute and where the blowoff pipe headwall is located, there is heavy rock riprap. From this point Lynde Brook flows through a steep narrow valley section for about 2,800 ft. before reaching State Route 9. At Route 9 the valley widens and flattens, and there are numerous residential and commercial buildings in this area. About 600 ft. below Route 9, Lynde Brook flows into Smiths Pond and Dam. Beyond Smiths Pond Lynde Brook is known as Kettle Brook and it follows a relatively narrow ravine for a distance of about 2,400 ft. Beyond this point the channel begins to widen and about 3 miles downstream of the dam it flows into Stoneville Pond (see Appendix D, Drawing D-20).

3.2 Evaluation

In general, the visual inspection adequately revealed key characteristics of the dam as they may relate to its stability and integrity, permitting an assessment to be made of those features affecting the safety of the structure. Minor seepage was noted from two areas along the downstream toe of the dam. No seepage was evident along the downstream slope of the dike. The crest and downstream slope of the dam and dike are well maintained. The outlet facilities all appeared to be in good working condition. Downstream control of the outlet gates is not advisable due to a continuous head in the conduit beneath the embankment. The spillway training walls are in good repair. The downstream spillway discharge channel training walls are low and may be overtopped during periods of high flow. For these reasons the Dam and Dike were judged to be in fair condition.

SECTION 4 - OPERATIONAL AND MAINTENANCE PROCEDURES

4.1 Operation Procedures

a. General. The dam is owned and operated by the City of Worcester Water Department. It is operated in conjunction with several other reservoirs to supply municipal water. A 24 in. dia. aqueduct connects it to Kettle Brook Reservoir No. 1 upstream. In the winter Lynde Brook Reservoir is generally drawn down slightly below the spillway crest elevation in order to provide storage for the excess spring runoff from other reservoirs.

b. Description of any Warning System in Effect. No warning system is in effect at Lynde Brook Reservoir Dam. The dam is visited daily.

4.2 Maintenance Procedures

a. General. There is no documented regular periodic maintenance program in effect at Lynde Brook Reservoir Dam. There are, however, several items which require and evidently receive periodic maintenance, such as: the upkeep of sod on the crest and downstream slope of the dam and dike; the removal of debris from the spillway crest; the repair of the spillway training walls; the surveillance of the embankment regarding seeps; and, the maintenance of the outlet structures and gates.

b. Operating Facilities. All outlet facilities appear to be well maintained and are reported to be in operating condition.

4.3 Evaluation

Overall maintenance of the dam is generally good. Specific maintenance items are evaluated as follows: the sod on the crest and downstream slope of both the dam and dike is in excellent condition; the crest of the spillway was free of debris; the spillway training walls are in good condition; there are two seeps along the downstream toe of the dam; and, all outlet facilities are reported to be in operating condition. The owner should establish a formal warning system for the dam in the event of an emergency.

SECTION 5 - EVALUATION OF HYDRAULIC/HYDROLOGIC FEATURES

5.1 General

Lynde Brook Reservoir Dam consists of two earth embankments impounding a normal storage of 2,300 acre-ft. with provision for an additional 437 acre-ft. of capacity in its surcharge space to the top of the dam. It is basically a high storage - low spillage facility used for water supply purposes. The spillway is capable of discharging about 560 cfs with the surcharge to the top of dam. The general topographic characteristics of the 2.80 sq. mi. (1,795 acre) drainage basin is best described as rolling terrain, which rises from elevation 824.0 at spillway crest to elevation 1,300. The upper reach of the drainage area is moderately populated and the Worcester Municipal Airport occupies the middle of the area. Southwick Pond is also located in the upper reaches of the drainage area. From the adjacent westerly drainage area an aqueduct drains to Lynde Brook Reservoir from Kettle Brook Reservoir No. 1. However, the inflow from Kettle Brook Reservoir No. 1 to the drainage basin is considered negligible for maximum flow computations.

5.2 Design Data

No hydrologic computation or hydraulic data has been recovered for the dam.

5.3 Experience Data

The only records available in regard to past operation of the reservoir are of water levels. These records are kept in the Worcester City Hall. It was reported by the operator of the dam that the dam has never been overtopped.

5.4 Test Flood Analysis

Hydrologic and hydraulic characteristics of Lynde Brook Reservoir Dam and drainage area were evaluated in accordance with the criteria given in Recommended Guidelines for Safety Inspection of Dams. For determining surface areas and surcharge capacities, planimetered areas were taken from contours delineated on U.S.G.S. 2,000 ft. per in. quadrangle sheets. Reservoir area and capacity curves and tables, for use in flood routing, are shown on Sheets D-2 and D-3, Appendix D.

As indicated in Section 1.2, paragraphs c and d, Lynde Brook Reservoir Dam is classified as intermediate in size and has a high hazard potential. The recommended test flood for the hydraulic evaluation of such a dam is a full PMF.

Precipitation data were obtained from Hydrometeorological Report No. 33, which for this area of Massachusetts is 23.0 in. of 6 hour maximum rainfall over a 10 square mile area. This value was then reduced by 20 percent to allow for basin size, shape and fit factors; an additional 0.4 in. was deducted for infiltration losses. The six hour rainfall was distributed into one hour incremental periods as suggested in Corps of Engineer Publication EC 1110-2-1411.

A triangular incremental unitgraph was assumed for the inflow hydrograph using a computed lag time of 4.38 hours to derive a time-to-peak for the triangular hydrograph of 4.0 hours (see computations on Sheets D-6 and D-7, Appendix D). The test flood hydrograph is shown on Sheet D-8, Appendix D, indicating a peak inflow of about 4,970 cfs or about a CSM value of 1,775.

Discharge tables and curves for the spillway and for over the top of the dam are shown on Sheets D-4 and D-5, Appendix D. The discharge from the 24 in. dia. low level outlet has been neglected.

Flood routings were performed for both the test flood and $\frac{1}{2}$ PMF. Results of these routings are shown on Sheets D-9 thru D-11, Appendix D, and are summarized as follows:

<u>Flood Magnitude</u>	<u>Routed Test Flood Inflow cfs</u>	<u>Maximum Res. El. ft. NGVD</u>	<u>Max. Head Over Main Dam ft.</u>	<u>Routed Test Flood Outflow cfs</u>
PMF (Test Flood)	4,970	828.3	1.0	4,350
$\frac{1}{2}$ PMF	2,485	827.9	0.6	2,100

From the above table, it can be seen that the project will not pass the routed test flood outflow without overtopping the dam by 1 ft. The project can handle about 13 percent of the routed test flood outflow without overtopping the dam.

5.5 Dam Failure Analysis

A breach from overtopping or due to structural failure of either the main dam or dike is a possibility. For this analysis a breach of each structure was considered separately as the breach outflows from the structures would initially follow different water courses. The "rule of thumb" method was used as a guide in computing the breach outflows.

Dam Failure. A breach width of 38 percent of the dam length was assumed for this analysis and a failure height from the bench at the toe of the embankment to the top of dam was assumed equal to 31 ft. Using these dimensions an outflow of about 55,000 cfs, which includes about 500 cfs from the spillway, would be realized. (see Sheets D-12 thru D-18, Appendix D).

Discharges from the breach would flow down Lynde Brook, thence to Kettle Brook. There are no structures in close proximity to Lynde Brook until the brook reaches State Route 9 about 2,800 ft. below the dam. However, because of the high breach discharge and small amount of valley storage between the dam and State Route 9, it is considered that severe flooding of commercial establishments and houses will take place in the vicinity of State Route 9. It is estimated that the discharge in this vicinity will be about 47,000 cfs and that the structures will be flooded to depths varying from 1 to 9 ft. About 13 houses and 7 commercial establishments would be flooded in this area. At this location, the culvert passing under State Route 9 is relatively small and it is estimated that State Route 9 would be overtopped by the spillway discharge alone, but no significant flooding of structures would probably take place under the spillway full flow condition. About 600 ft. below State Route 9 Lynde Brook empties into Smiths Pond where it is estimated that there will be flooding of at least five homes and a mill located near the outlet of the pond. The depth of flooding around the structures in this area is estimated to be between 3 and 7 ft. and that no flooding of these structures would occur under the spillway full conditions.

Beyond Smiths Pond the water course is known as Kettle Brook, which follows a relatively narrow ravine for a distance of about 2,400 ft. to another dam which is part of a mill complex. It is estimated that the discharge in the brook at this point will be about 31,000 cfs, and that the brook will rise about 17 ft. because of the breach, severely flooding the adjacent fill. An inspection of the waterway opening under Strafford Street, located about 2.1 miles below Lynde Brook Reservoir Dam, indicated that the capacity of the waterway is adequate to convey the spillway full discharge, but inadequate to handle the breach discharge. The street as well as a mill complex located south of Strafford Street will be significantly flooded. James Street, located about 2,000 ft. further downstream, will also be flooded and three houses near the brook in this area will probably sustain damage. Beyond James Street, the brook empties into Stoneville Pond where the flood wave should be significantly reduced.

Dike Failure. For this failure analysis a breach width of 20 percent of the dike's length at mid-height was used equal to 130 ft. The height of the breach was assumed from the toe of the dike to the top of the embankment a distance of about 14 ft. Using these dimensions an outflow of about 11,800 cfs would be realized. (See Sheets D-21 thru D-25, Appendix D).

Discharges from the breach would flow down an unnamed water course for a distance of about 7,000 ft. until reaching an underground conduit which has twin barrels about 2.5 ft. high and 5 ft. The conduit would not be adequate to handle the breach discharge and it is estimated that about 9,000 cfs would spill across State Route 9, down over a steep embankment and into a large residential area. The outflow would then cross Stafford Avenue and return to Kettle Brook to the same damage reach as described under the dam failure analysis.

About 2,800 ft. below the dike there are about 4 homes in the Cherry Valley section of Leicester that would sustain flooding due to the breach. It is estimated that the depth of flooding in this area would be between 2 and 6 ft. In the area of State Route 9 and the area between State Route 9 and Stafford Avenue, it is estimated that from 50 to 70 homes, 6 commercial establishments, a school and a church would be flooded to depths ranging between 1 and 9 ft.

In summary, in the initial impact areas described above there is considerable urban development and more than a small number of habitable structures which would be flooded by a breach of either the dam or dike at Lynde Brook Reservoir. It is estimated that economic losses due to a breach would be excessive. There is also the potential for the loss of more than a few lives. Sheet D-26, Appendix D shows the area of potential flooding.

SECTION 6 - EVALUATION OF STRUCTURAL STABILITY

6.1 Visual Observations

There are no design calculations, as-built drawings or other data which would permit the preparation of structural stability computations. The dam is now stable and is in good condition. The only deficiency that should be monitored is the minor seepage in two locations at the downstream toe of the dam.

6.2 Design and Construction Data

No plan or calculations of value to a stability assessment are available.

6.3 Post-Construction Changes

There are no records of any post-construction changes made to the dam, dike or spillway that are of significance to the stability of the facility.

6.4 Seismic Stability

The dam is located in Seismic Zone No. 2 and in accordance with recommended Phase I guidelines, does not warrant seismic analysis.

SECTION 7

ASSESSMENT, RECOMMENDATIONS AND REMEDIAL MEASURES

7.1 Dam Assessment

a. Condition. On the basis of the Phase I visual examination, Lynde Brook Reservoir Dam and Dike appear to be in good condition. Structurally, however the overall rating must be fair due to spillway inadequacy. The deficiencies revealed indicate that a further investigation should be carried out and that some remedial work is needed. The major concerns of the overall integrity of the dam are as follows:

- (1) The spillway can only pass 13 percent of the routed test flood outflow.
- (2) There is minor seepage at locations along the downstream toe of the dam.
- (3) The control of the outlet facilities downstream of the embankment results in the conduit being under continuous head.

b. Adequacy of Information. The lack of in-depth engineering data did not allow for a definitive review. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing design and construction data, but is based primarily on visual inspection, past performance history and sound engineering judgement.

c. Urgency. The recommendations and remedial measures enumerated below should be implemented by the owner within one year after receipt of this Phase I Inspection Report.

7.2 Recommendations

It is recommended that the owner should retain the services of a registered professional engineer experienced in the design of earthdams to make investigations and studies of the following, and if proved necessary, to design appropriate remedial works.

- (1) Make a detailed hydrologic-hydraulic investigation to assess further the potential for overtopping and the adequacy of the spillway.
- (2) Make a yearly evaluation of the seepage at the downstream toe of the dam.
- (3) Perform a detailed analysis to provide means of positive closure on upstream end of conduit.
- (4) Investigate whether spillway discharge channel modifications are required to forestall possible overtopping of the walls.

7.3 Remedial Measures

a. Operating and Maintenance Procedures

- (1) Develop a formal surveillance and downstream emergency warning plan, including round-the-clock monitoring during periods of heavy precipitation.

(2) Institute procedures for an annual periodic technical inspection of the dam and dike and its appurtenant structures, including the minor seepage.

(3) Prepare a copy of the dam outlet control plan.

7.4 Alternatives

There appear to be no feasible alternatives to the above recommendations.

APPENDIX A
INSPECTION CHECKLIST

VISUAL INSPECTION CHECKLIST
PARTY ORGANIZATION

PROJECT LYNDE BROOK RESERVOIR DAM DATE 4/16/80
OWNER: CITY OF WORCESTER TIME 9:30 a.m.
WEATHER Cloudy
W.S. ELEV. 824.0 U.S. NA DN.S.

INSPECTION PARTY

PARTY: A/E REPRESENTATIVES

OWNER'S REPRESENTATIVES

1. Peter B. Dyson
2. Pasquale E. Corsetti
3. Roger F. Berry
4. Carl J. Hoffman
5. William S. Zoino

1. Mike Pascal
2. Ed Foisy
- _____
- _____
- _____

PROJECT FEATURE	INSPECTED BY	REMARKS
1. <u>Hydrologic</u>	<u>Roger F. Berry</u>	<u>LBA</u>
2. <u>Hydraulics/Structures</u>	<u>Carl J. Hoffman</u>	<u>LBA</u>
3. <u>Soils & Geology</u>	<u>William S. Zoino</u>	<u>GZA</u>
4. <u>General Features</u>	<u>Peter By Dyson</u>	<u>LBA</u>
5. <u>General Features</u>	<u>Pasquale E. Corsetti</u>	<u>LBA</u>
6. _____	_____	_____
7. _____	_____	_____
8. _____	_____	_____
9. _____	_____	_____
10. _____	_____	_____

LBA - Louis Berger & Associates, Inc.
GZA - Goldberg-Zoino & Associates, Inc.

PERIODIC INSPECTION CHECKLIST

PROJECT LYNDE BROOK RESERVOIR DAM DATE 4/16/80

PROJECT FEATURE EARTH EMBANKMENT NAME

DISCIPLINE GEOTECHNICAL NAME W. ZOINO

AREA EVALUATED CONDITIONS

DAM EMBANKMENT SOUTH DAM

Crest Elevation	827.5
Current Pool Elevation	824.0
Maximum Impoundment to Date	Unknown
Surface Cracks	None
Pavement Condition	N/A
Movement or Settlement of Crest	None
Lateral Movement	None
Vertical Alginment	Good
Horizontal Alignment	Good
Condition at Abutment and at Concrete Structures	Good
Indications of Movement of Structural Items on Slopes	None
Trespassing on Slopes	None
Sloughing or Erosion of Slopes or Abutments	None
Rock Slope Protection - Riprap Failures	Good condition
Unusual Movement or Cracking at or near Toes	None
Unusual Embankment or Downstream Seepage	2 minor seeps less than 0.1 gpm at toe
Piping or Boils	None
Foundation Drainage Features	None evident
Toe Drains	None evident
Instrumentation System	None evident

PERIODIC INSPECTION CHECKLIST

PROJECT LYNDE BROOK RESERVOIR DAM DATE 4/16/80
 PROJECT FEATURE EARTH EMBANKMENT NAME W. Zoino
 DISCIPLINE GEOTECHNICAL NAME _____

AREA EVALUATED		CONDITIONS
<u>DIKE EMBANKMENT</u>	EAST DIKE	
Crest Elevation		827.35
Current Pool Elevation		824.0
Maximum Impoundment to Date		Unknown
Surface Cracks		None
Pavement Condition		N/A
Movement or Settlement of Crest		None
Lateral Movement		None
Vertical Alignment		Good
Horizontal Alignment		Good
Condition at Abutment and at Concrete Structures		Good
Indications of Movement of Structural Items on Slopes		None
Trespassing on Slopes		None
Sloughing or Erosion of Slopes or Abutments		None
Rock Slop Protection - Riprap Failures		Small sized 6"-12", but in good condition.
Unusual Movement or Cracking at or near Toes		None
Unusual Embankment or Downstream Seepage		None
Piping or Boils		None evident
Foundation Drainage Features		None evident
Toe Drains		None evident
Instrumentation System		None evident

PERIODIC INSPECTION CHECKLIST

PROJECT LYNDE BROOK RESERVOIR DAM DATE 4/16/80
 PROJECT FEATURE OUTLET CONTROL STRUCTURES NAME _____
 DISCIPLINE STRUCTURAL NAME C. HOFFMAN

AREA EVALUATED	CONDITIONS	
<u>OUTLET WORKS - CONTROL TOWER</u>	<u>CONTROL HOUSE AT TOE OF SO. DAM</u>	<u>CONTROL TOWER AT EAST DIKE</u>
a. Concrete and Structural		
General Condition	Good	Good
Condition of Joints	Good	Good
Spalling	None	None
Visible Reinforcing	None	None
Rusting or Staining of Concrete	None	None
Any Seepage or Efflorescence	None	None
Joint Alignment	Good	Good
Unusual Seepage or Leaks in Gate Chamber	None evident	Unknown
Cracks	None	None
Rusting or Corrosion of Steel	Minor on gate stems	None
b. Mechanical and Electrical	N/A	N/A
Air Vents		
Float Wells		
Crane Hoist		
Elevator		
Hydraulic System		
Service Gates		
Emergency Gates		
Lighting Protection System		
Emergency Power System		
Wiring and Lighting System in Gate Chamber		

PERIODIC INSPECTION CHECKLIST

PROJECT LYNDE BROOK RESERVOIR DAM DATE 4/16/80
 PROJECT FEATURE Spillway NAME _____
 DISCIPLINE Structures NAME C. Hoffman

AREA EVALUATED	CONDITIONS
----------------	------------

OUTLET WORKS - SPILLWAY WEIR, APPROACH AND DISCHARGE CHANNELS

a. Approach Channel

General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Approach Channel	Paved

b. Weir and Training Walls

General Condition of Concrete	Good
Rust or Staining	Minor
Spalling	None
Any Visible Reinforcing	None
Any Seepage or Efflorescence	Minor
Drain Holes	N/A

c. Discharge Channel

General Condition	Good
Loose Rock Overhanging Channel	None
Trees Overhanging Channel	None
Floor of Channel	Paved
Other Obstructions	None

PERIODIC INSPECTION CHECKLIST

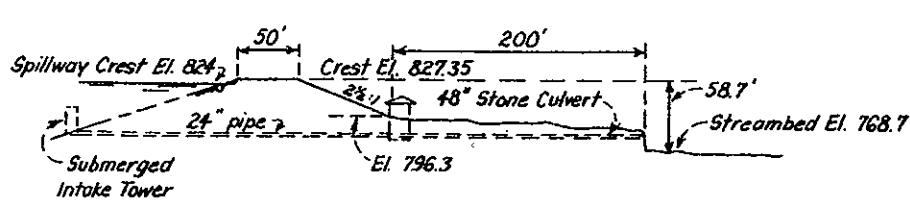
PROJECT LYNDE BROOK RESERVOIR DAM DATE 4/16/80

PROJECT FEATURE _____ NAME _____

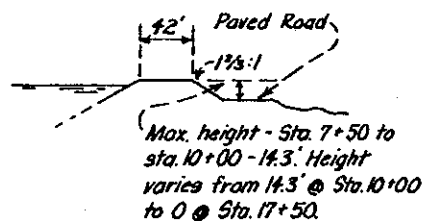
DISCIPLINE _____ NAME _____

AREA EVALUATED	CONDITIONS
Outlet Works - Intake Channel and Intake Structure	N/A
Outlet Works - Transition & Conduit	N/A
Outlet Works - Outlet Structure and Outlet Channel	N/A
Outlet Works - Service Bridge	N/A

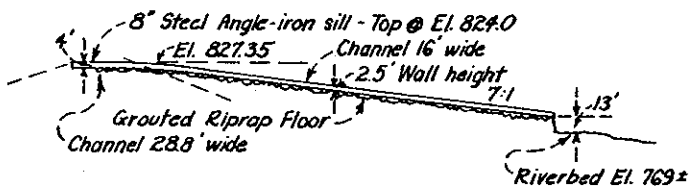
APPENDIX B
ENGINEERING DATA



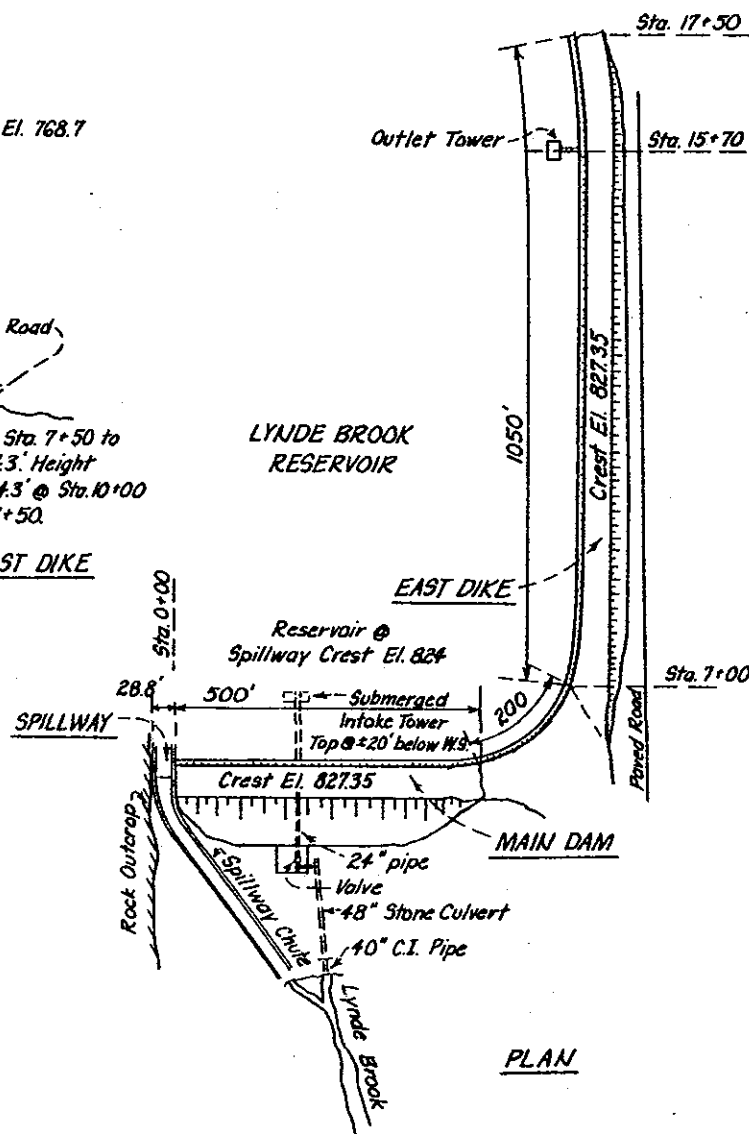
SECTION THRU MAIN DAM



SECTION THRU EAST DIKE

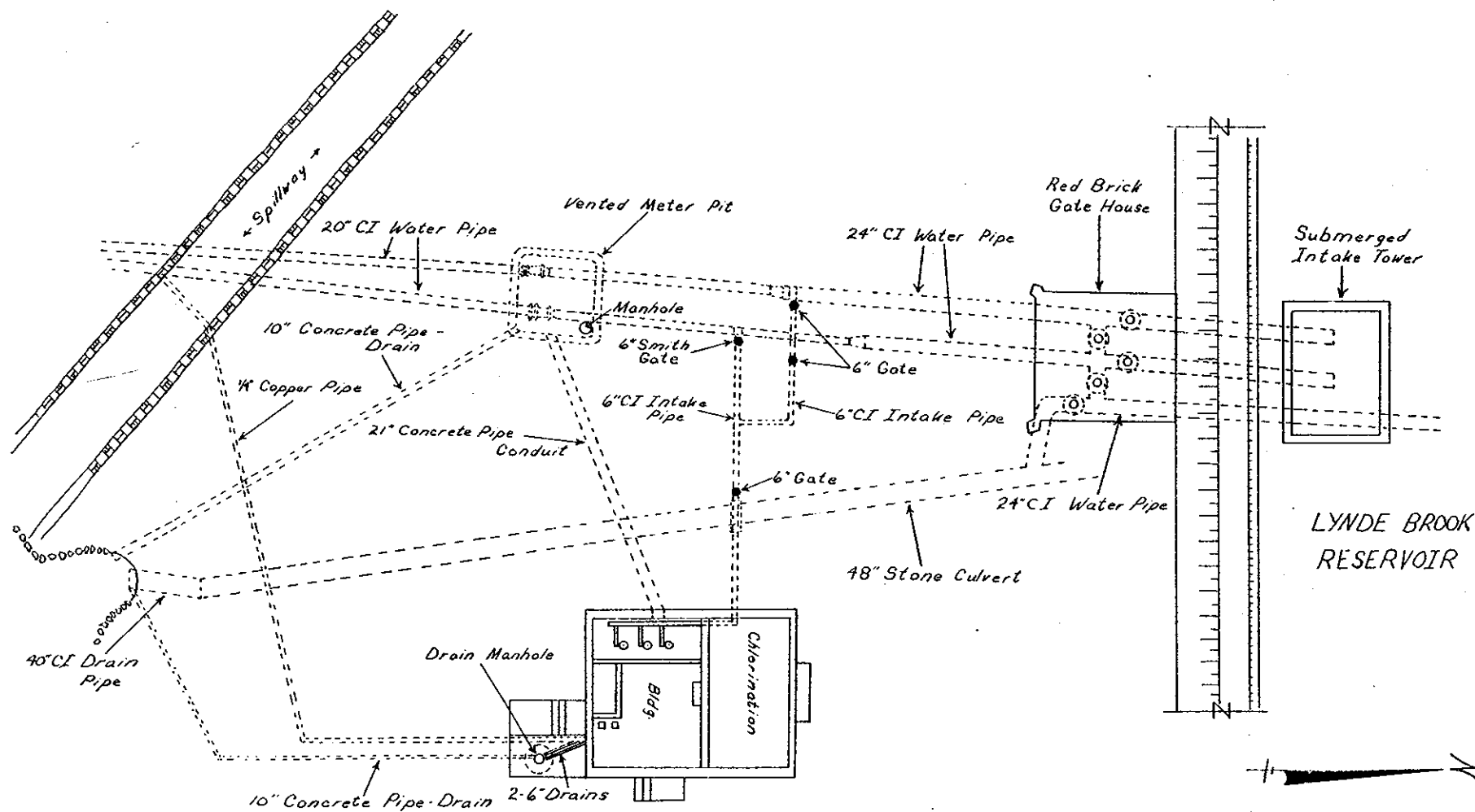


SPILLWAY PROFILE



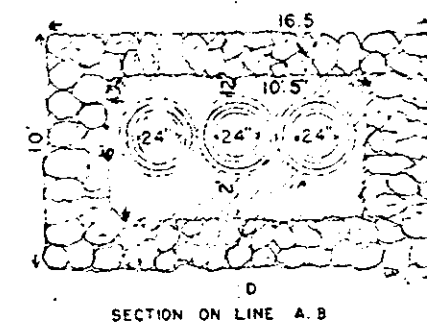
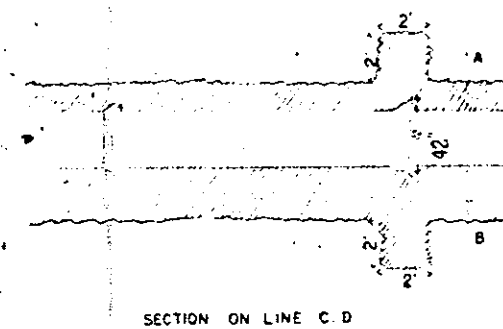
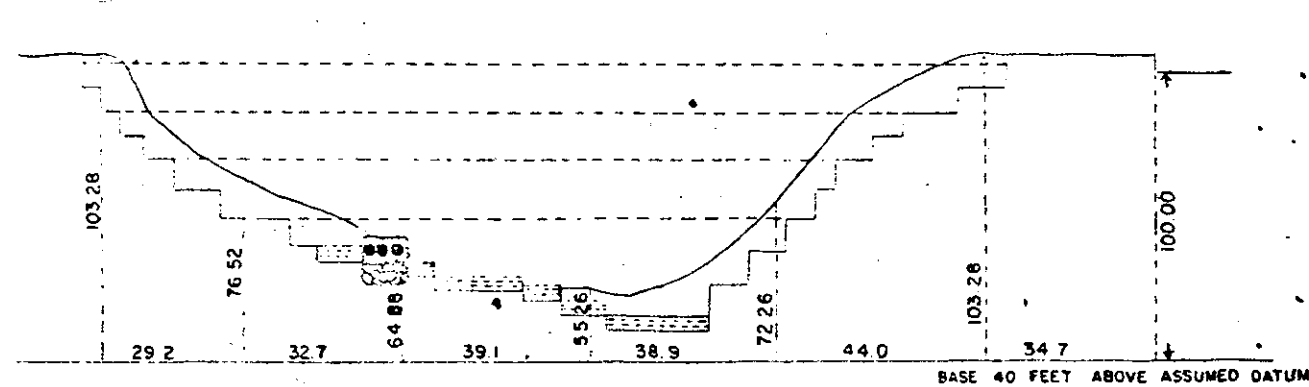
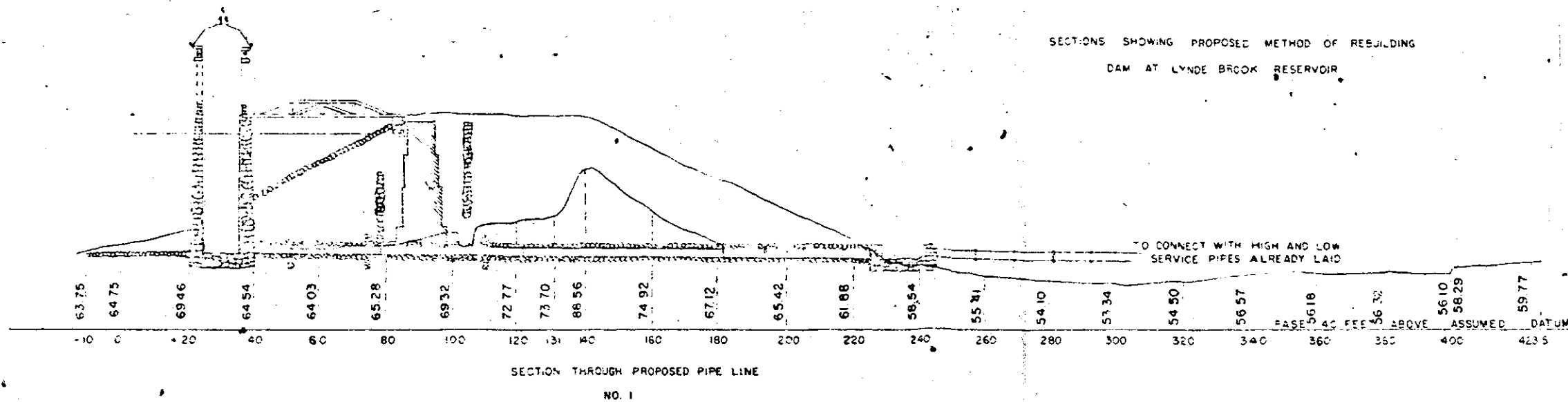
PLAN

LYNDE BROOK RESERVOIR DAM



SKETCH OF OUTLET CONTROL

SECTIONS SHOWING PROPOSED METHOD OF RESUILDING
DAM AT LYNDE BROOK RESERVOIR



SECTION ON LINE C. D.

SECTION ON LINE A. B.

DETAILS SHOWING CUT-OFF WALL
NO. 3

SCALE OF NOS. 1 & 2 = 20 FEET TO AN INCH
" NOS 3 & 4 = 4 " " " "

C. H. V. BLAKE, CITY ENGINEER
APPROVED
WM J. MCALPINE, CONSULTING ENGINEER.
APRIL 1876

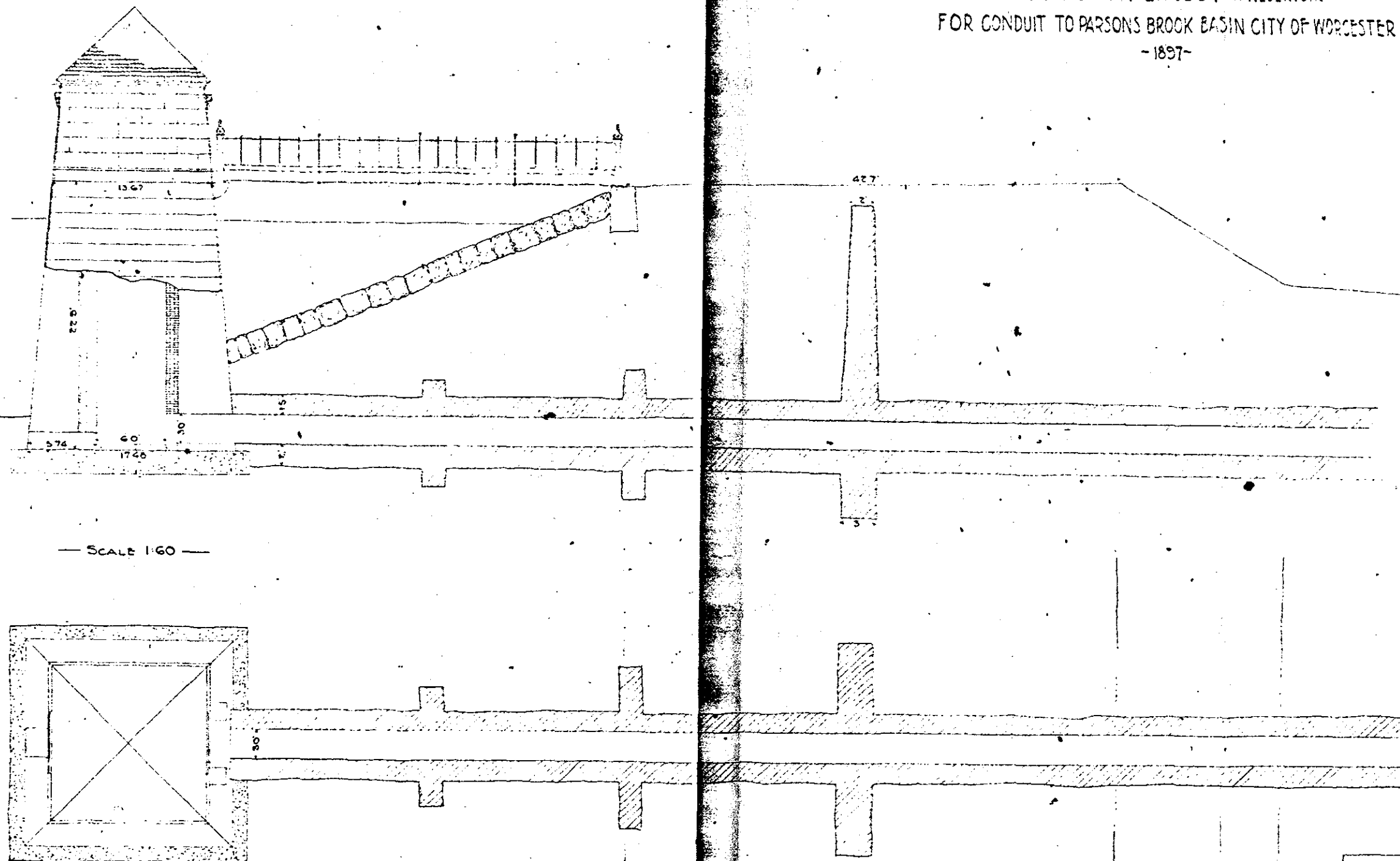
IN BOARD OF ALDERMEN APRIL 17, 1876
APPROVED AND ADOPTED BY THIS BOARD,
SENT DOWN FOR CONCURRENCE.

SAMUEL SMITH CLECK IN COMMON COUNCIL
APRIL 17, 1876 CONCURRED
HAMILTON COE CLECK.
APPROVED APRIL 18, 1876
CLARK JILLSON MAYOR

WORCESTER COUNTY COMMISSIONERS
WORCESTER COUNTY ENGINEERING DEPARTMENT
PLAN OF
DAM
LYNDE BROOK RESERVOIR DAM
LEICESTER MASS
FOR THE CITY OF WORCESTER
AS FILED AND APPROVED BY THE
COUNTY COMMISSIONERS
MARCH MEETING 1876 DOCKET 370

TRACED BY P.P.P.
TRACING CHECKED BY W.L.E.
DAM NO 25
COUNTY ENGINEER

DISCHARGE FROM LYNDE BROOK RESERVOIR
FOR CONDUIT TO PARSONS BROOK BASIN CITY OF WORCESTER
-1897-



WORCESTER COUNTY COMMISSIONERS
WORCESTER COUNTY ENGINEERING DEPARTMENT
PLAN OF
DAM
AT LYNDE BROOK RESERVOIR
LEICESTER, MASS.
FOR THE CITY OF WORCESTER
AS FILED AND APPROVED BY THE
COUNTY COMMISSIONERS
APRIL 22, 1897
MARCH MEETING DOCKET 262
SCALES AS NOTED

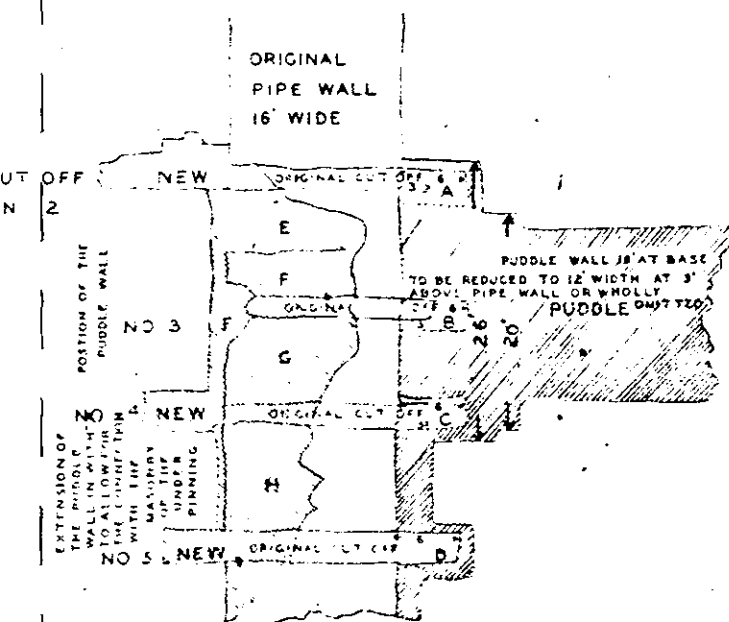
TRACED BY: *K. M. Sullivan*
TRACING CHECKED BY: *J. D. Sullivan*
COUNTY ENGINEER

Attest *William C. Bower*
Clerk

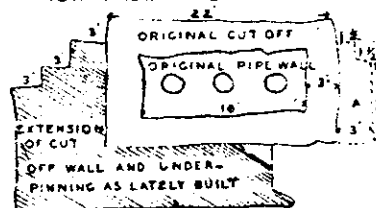
WORCESTER AUGUST 24, 1876
THIS PLAN IS HEREBY APPROVED BY THE COMMITTEE
ON RE-CONSTRUCTION OF THE DAM AT LYNDE BROOK
RESERVOIR
CHARKE JILLSON
MAYOR AND CHAIRMAN OF COMMITTEE.

PLAN
AUGUST 31, 1876.
ATTEST JOHN A. DANA
ASST. CLERK

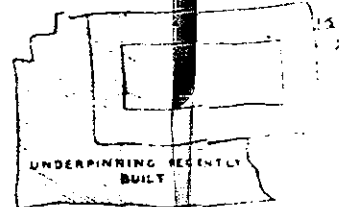
SCALE 9 FEET TO AN INCH
DRAWN FROM RECOLLECTION WITHOUT ANY
MEASUREMENTS BEFORE ME
ENGR. W. J. M.



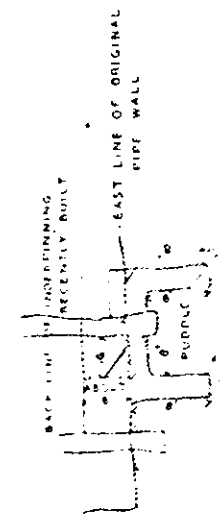
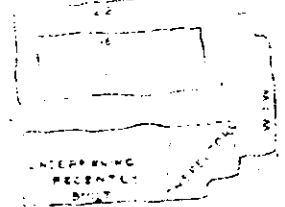
ELEVATION OF
CUT OFF NO 2
VIEW FROM THE SOUTH



ELEVATION OF
CUT OFF NO 3
FROM THE NORTH



ELEVATION OF CUT OFF WALL NO 3
WITH THE ADDITION PROPOSED BY THE
INSPECTORS BUT AGAIN MODIFIED BY W. J. M.



NOTE
THIS ARRANGEMENT OF THE PUDDLING AND OF
THE DIMENSIONS MUST BE STRICTLY ADHERED TO.
IT IS OF VASTLY MORE CONSEQUENCE THAN THE
DEPTH TO WHICH THE MASONRY ON THE
PUDDLE IS EXTENDED AT THIS PLACE

NOTE
THE NEW MASONRY PROPOSED BY THE INSPECTORS FOR THE EXTENSION
OF THE CUT OFF ON THE LINE OF CUT OFF NO 3 IS DRAWN 6 FEET
WIDE AND I HAVE ADDED AT THE END THERE OF A FACE WALL OF
5 FEET THICK UNDERPINNING THE PIPE WALL
ALSO TWO WING WALLS OF 6 FEET LONG AND 2 FEET THICK TO MAKE
THE CONNECTION WITH THE THE LAST PUDDLE WALL SAFER
ALL THE OTHER WORK SHOWN ON THIS PLAN MUST BE DONE IN
ADDITION TO THE WORK PROPOSED BY THE INSPECTORS

BABYLON AUGUST 22, 1876
W. J. M. MALPINE
CONSULTING
ENGINEER

NOTE
A B C AND D SHOW EXTENSION OF ORIGINAL
CUT OFFS ORDERED BY W. J. M.
E F G AND H NEW UNDERPINNING OF
PIPE WALL RECENTLY BUILT.
THE MASONRY WHICH HAS BEEN PUT IN
RECENTLY ON THE WEST SIDE OF THE
PIPE WALL IS SHADED WITH LINES.

WORCESTER COUNTY COMMISSIONERS
WORCESTER COUNTY ENGINEERING DEPARTMENT
PLAN OF
LYNDE BROOK RESERVOIR DAM
LEICESTER, MASS
FOR THE CITY OF WORCESTER
AS FILED AND APPROVED BY THE
COUNTY COMMISSIONERS
JUNE MEETING DOCKET
SCALES AS NOTED
TRACED BY PEZZELLA
TRACING CHECKED BY W. J. M.
APPROVED BY
DAM NO 25

TOWN OR CITY *Leicester*
LOCATION

DECREE NO. *262.*

PLAN NO.

DAM NO. *25-25*

C. C. DOCKET NO.

DESCRIPTION OF DAM

Type *Earth-concrete core wall.*
Length
Height *40'*
Thickness top *50'*
" bottom *240'*
Downstream Slope *2:1*
Upstream " *2:1 rip-rap*
Length of Spillway
Size of Gates *3-24" Pipes*
Location of Gates *Upstream left*
Flashboards used
Width Flashboards or Gates
Dam designed by *Wm. J. McAlpine 1876*
" constructed by
Year constructed

GENERAL REMARKS

Owned by City of Worcester Water Dept.
Vol. 26, P. 102 Oct. 9, 1877.
" 25, P. 366, May 25, 1876.
" 25 - P. 391 - April 17, 1876.
Specifications for repairs - March meeting 1876

DESCRIPTION OF RESERVOIR & WATERSHED

Name of Main Stream *Lynde Brook.*
" " any other Streams
Length of Watershed
Width " "
Is Watershed Cultivated
Percent in Forests
Steepness of Slope
Kind of Soil
No. of Acres in Watershed
" " " " Reservoir *132.*
Length of Reservoir
Width " "
Max Flow Cu. Ft per Sec.
Head or Flashboards-Low Water
" " " " -High "

GENERAL REMARKS

L. O. Marden
Inspected: Dec. 7, 1928 " " "
" : Nov. 19, 1929 - L. Goodale & R. Lingley
" : Aug. 24, 1932 - " "
" : April 15, 1937 - K. M. Finlayson
" : Oct. 13, 1938 - L. H. Spofford
" : Dec. 10, 1940 - " " "
" : Sept. 16, 1943 - L. O. M. Perry - Starbuck
2 - Library Bureau 10-92260

Inspected: Dec. 10, 1945 - M. F. Haat
" Nov. 18, 1947 - E. Perry - L. O. M. - Haroy
" Jan. 7, 1953 - L. H. Spofford & Lloyd Starbuck
" May 25, 1960 - L. O. M. - Starbuck

25-25

COUNTY OF WORCESTER MASSACHUSETTS
COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by LOM- L. Goodale-L. Lingley Date Nov. 19, 1929, Dam No. 25-25

Town Leicester Location

Owner Use

Material and Type

Dam Designed by Constructed by Year

SPILLWAY

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition OK, except abutment walls will have to be rebuilt acct frost action etc. -to be done 1930.

EMBANKMENT

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition OK

GATES Location

Size Kind El. Flowline

Condition OK

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure

Recent Repairs and Date

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by.....K. M. Finlayson.....Date 4-15-37.....Dam No. 25-25

Town.....Leicester.....Location.....Lynds Brook Res.

Owner.....Use.....

Material and Type.....

Dam Designed by.....Constructed by.....Year.....

SPILLWAY—Length.....Feet. Depth.....Feet

El. top Abutment.....El. Crest.....El. Apron.....El. Streambed.....

Width top Abutment.....Width top Crest.....Width bottom Spillway.....

Width Flashboards carried.....Kind Flashboards.....

El. Flowline Cleanout Pipe.....Size and Kind Cleanout Pipe.....

Kind of Foundation under Spillway.....

Condition.....OK.....

EMBANKMENT—Length overall.....Feet

El. Top.....El. Natural Ground.....Width Top.....

Width of Bottom.....Upstream Slope.....Downstream Slope.....

Kind of Corewall.....Riprap.....

Material in Embankment.....Foundation.....

Condition.....OK.....

GATES.....Location.....

Size.....Kind.....El. Flowline.....

Condition.....OK.....

WHEEL.....Kind.....Size.....Rated H. P.....

Location.....Ave. Head.....

Evidence of Leaks in Structure.....

Recent Repairs and Date.....

Topography of Country below Dam.....

Nature of Buildings and Roads below Dam.....

Number of Acres in Pond.....Drainage Area in Square Miles.....

Discharge in Second Feet per Square Mile.....

Estimated Storage Million Cubic Feet.....

COUNTY OF WORCESTER MASSACHUSETTS

COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by L.H. Spofford Date Oct. 13, 1938 Dam No. 25-25

Town Leicester Location Lynde Brook Reservoir
Owner Worcester Water Dept Use Water Supply
Material and Type Earth Embankment

Dam Designed by _____ Constructed by _____ Year _____

1- **SPILLWAY** Grouted Stone 30' lg x 4' wide uniform below spill walls

El. top Abutment _____ El. Crest _____ El. Apron _____ El. Streambed _____

Width top Abutment _____ Width top Crest _____ Width bottom Spillway _____

Width Flashboards carried _____ Kind Flashboards _____

El. Flowline Cleanout Pipe _____ Size and Kind Cleanout Pipe _____

Kind of Foundation under Spillway _____

Condition Excellent - Information from caretaker is that flood was two feet over the crest of the spillway.

EMBANKMENT

El. Top _____ El. Natural Ground _____ Width Top _____

Width of Bottom _____ Upstream Slope _____ Downstream Slope _____

Kind of Corewall _____ Riprap _____

Material in Embankment _____ Foundation _____

Condition Excellent - no seepage or damage.

GATES 2 sets in gate houses.

Location _____

Size _____ Kind _____ El. Flowline _____

Condition _____

WHEEL _____ Kind _____ Size _____ Rated H. P. _____

Location _____ Ave. Head _____

Evidence of Leaks in Structure _____

Recent Repairs and Date _____

Topography of Country below Dam _____

Nature of Buildings and Roads below Dam _____

Number Acres in Pond _____ Drainage Area in Square Miles _____

Discharge in Second Feet per Square Mile _____

Estimated Storage Million Cubic Feet _____

COUNTY OF WORCESTER MASSACHUSETTS
COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by J. H. Spufford Date Dec 10 / 40 Dam No. 25-25

Town Fairfax Location Lyle Brook Reservoir

Owner City of Worcester Water Dept Use

Material and Type Earth Embankment

Dam Designed by Constructed by Year

SPILLWAY

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition Excellent

EMBANKMENT

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition Excellent

GATES Location In gate House

Size Kind El. Flowline

Condition

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure None

Recent Repairs and Date None

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet

WORCESTER COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs

Inspected by Mr. E. Perry - L. H. H. H. Date 9-16-43 Dam No. 25-25

Town Leicester Location Lyn. B.
Owner _____ Use _____

SPILLWAY

El. top Abutment _____ El. Crest _____ El. Apron _____ El. St. Bed _____
Width top Abut. _____ Width top Crest _____ Width bottom Sp. way _____
Width flashboards _____ Kind Flashboards _____
El. Flowline Cleanout Pipe _____ Size and Kind Pipe _____
Kind of Foundation under Spillway _____
Condition OK

EMBANKMENT

El. Top _____ El. Natural Ground _____ Width Top _____
Width of Bottom _____ Upstream Slope _____ Downstream Slope _____
Kind of Corewall _____ Riprap _____
Material in Embankment _____ Foundation _____
Condition OK

GATES

Location _____
Size _____ Kind _____ El. Flowline _____
Condition OK

Evidence of Leaks in Structure OK

Recent Repairs and Date _____

Number Acres in Pond _____ Drainage Area in Sq. Miles _____

Discharge in Second Feet per Square Mile _____

Estimated Storage Million Cubic Feet 701

COUNTY OF WORCESTER MASSACHUSETTS
COUNTY ENGINEER

Inspection of Dams, Reservoir Dams, and Reservoirs.

Inspected by M.E. Hunt Date Dec. 10, 1945 Dam No. 25-25

Town Worcester Location Lynde Brook Res.

Owner City of Worcester Water Dept Use

Material and Type

Dam Designed by Constructed by

SPILLWAY

El. top Abutment El. Crest El. Apron El. Streambed

Width top Abutment Width top Crest Width bottom Spillway

Width Flashboards carried Kind Flashboards

El. Flowline Cleanout Pipe Size and Kind Cleanout Pipe

Kind of Foundation under Spillway

Condition O.K.

EMBANKMENT

El. Top El. Natural Ground Width Top

Width of Bottom Upstream Slope Downstream Slope

Kind of Corewall Riprap

Material in Embankment Foundation

Condition O.K.

GATES Location

Size Kind El. Flowline

Condition O.K.

WHEEL Kind Size Rated H. P.

Location Ave. Head

Evidence of Leaks in Structure

Recent Repairs and Date

Topography of Country below Dam

Nature of Buildings and Roads below Dam

Number Acres in Pond Drainage Area in Square Miles

Discharge in Second Feet per Square Mile

Estimated Storage Million Cubic Feet

TOWN Leicester

DAM NO. 25-25

LOCATION Lynde Brook Res.

STREAM Lynde Br.

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

OWNED BY Worcester Water Dept. PLACE Worcester USE storage

INSPECTED BY E. Perry-Hardy-Marden DATE Nov. 18, 1947.

TYPE OF DAM Earth emb..stone spillway CONDITION good

SPILLWAY

FLASHBOARDS IN PLACE none RECENT REPAIRS none

CONDITION good

REPAIRS NEEDED none

EMBANKMENT

RECENT REPAIRS none

CONDITION good

REPAIRS NEEDED none

GATES

RECENT REPAIRS none

CONDITION good

REPAIRS NEEDED none

LEAKS

HOW SERIOUS none visible.

DATE Feb. 6, 1947

E. O. Marden
COUNTY ENGINEER

TOWN Lancaster
LOCATION Lynde Brook

✓ DAM NO. 25-25
STREAM _____

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

OWNED BY City of Worcester PLACE _____ USE Reservoir
INSPECTED BY H. Spofford + Lloyd Steward DATE Jan 7 1953
TYPE OF DAM Earth CONDITION Excellent

SPILLWAY

FLASHBOARDS IN PLACE None RECENT REPAIRS None
CONDITION Excellent
REPAIRS NEEDED None

EMBANKMENT

RECENT REPAIRS None
CONDITION Excellent
REPAIRS NEEDED None

GATES

RECENT REPAIRS None
CONDITION Excellent
REPAIRS NEEDED None

LEAKS

HOW SERIOUS None

DATE 1/7/53

COUNTY ENGINEER

TOWN Leicester DAM NO. 25-25
LOCATION W. side of Reservoir St. STREAM Lynde Brook
"Lynde Brook Res."

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

D A M I N S P E C T I O N R E P O R T

Owned by City of Worcester Place Water Dept. Use Water Supply
Inspected by WOL Date 9-13-55
Type of Dam Earth-Stone Condition Good

SPILLWAY

Flashboards in Place No boards Recent Repairs _____
Condition Water level is 1' below crest of spillway
Repairs Needed Minor work on downstream paved channel

EMBANKMENT

Recent Repairs _____
Condition Good
Repairs Needed _____

GATES

Recent Repairs _____
Condition Good
Repairs Needed _____

LEAKS

How Serious No leaks

DATE: _____ County Engineer

TOWN Leicester

DAM NO. 25-25

LOCATION Lynde Brook Res

STREAM _____

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

OWNED BY H. W. D PLACE Worce USE Water supply

INSPECTED BY LOM DATE May 8, 1957

TYPE OF DAM Earth stone CONDITION _____

SPILLWAY

FLASHBOARDS IN PLACE None RECENT REPAIRS _____

CONDITION Good

REPAIRS NEEDED None

EMBANKMENT

RECENT REPAIRS None

CONDITION Good

REPAIRS NEEDED None

GATES

RECENT REPAIRS None

CONDITION Good

REPAIRS NEEDED None

LEAKS

HOW SERIOUS None visible

DATE May 8, 1957

P. O. Ward
COUNTY ENGINEER

TOWN Leicester

DAM NO. 25-25

LOCATION Lynde Br Rci

STREAM Lynde Rl

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS
DAM INSPECTION REPORT

OWNED BY W. W. D PLACE Mass USE Dr. H. H.

INSPECTED BY LOM DATE May 8, 1957

TYPE OF DAM Earth - Masonry CONDITION Good

SPILLWAY

FLASHBOARDS IN PLACE — RECENT REPAIRS None

CONDITION Good

REPAIRS NEEDED None

EMBANKMENT

RECENT REPAIRS None

CONDITION Good

REPAIRS NEEDED None

GATES

RECENT REPAIRS None

CONDITION Good

REPAIRS NEEDED None

LEAKS

HOW SERIOUS None

DATE May 8, 1957

P. D. Mearns
COUNTY ENGINEER

TOWN Leicester

DAM NO. 25-25

LOCATION Lynde Brook Res

STREAM _____

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

D A M I N S P E C T I O N R E P O R T

Owned by Bureau of Hydro. Works Place _____ Use _____

Inspected by L. Stakhard - L.O.M. Date 5-25-61

Type of Dam _____ Condition Good

SPILLWAY

Flashboards in Place _____ Recent Repairs _____

Condition Good

Repairs Needed None

EMBANKMENT

Recent Repairs None

Condition Good

Repairs Needed _____

GATES

Recent Repairs None

Condition Gates in Gate House

Repairs Needed None

LEAKS

How Serious _____

DATE: May 25, 1961

L.O. Marden
County Engineer

APPENDIX C

PHOTOGRAPHS

TOWN Leicester DAM NO. 25-25

LOCATION Lynbrook Res STREAM _____

WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

DAM INSPECTION REPORT

Owned by _____ Place _____ Use _____

Inspected by Reynolds Date _____

Type of Dam _____ Condition _____

SPILLWAY

Flashboards in Place Yes Recent Repairs _____

Condition Level 9" above crest

Repairs Needed _____

EMBANKMENT

Recent Repairs _____

Condition _____

Repairs Needed _____

GATES

Recent Repairs open

Condition _____

Repairs Needed _____

LEAKS

How Serious _____

DATE: 27 March 1969

County Engineer

TOWN Leicester DAM NO. 25-25
LOCATION Reservoir Road. STREAM Lynde Brook

Lynde Brook Reservoir
WORCESTER COUNTY ENGINEERING DEPARTMENT
WORCESTER, MASSACHUSETTS

D A M I N S P E C T I O N R E P O R T

Owned by City of Worcester Place Water Dept Use Water Supply
Inspected by WCH Date Nov. 5, 1963
Type of Dam Earth, stone and concrete. Condition Good

SPILLWAY

Flashboards in Place _____ Recent Repairs _____
Condition Good.
Repairs Needed _____

EMBANKMENT

Recent Repairs This reservoir is now dry. - this reservoir has not
Condition been used for a few years due to the silting and
Repairs Needed discoloration of this stream on account of the new
construction at the Worcester Municipal Airport.

GATES

Recent Repairs _____
Condition Good.
Repairs Needed _____

LEAKS

How Serious _____

DATE: _____ County Engineer

LOUIS BERGER & ASSOC., INC.
WELLESLEY, MASS.
ARCHITECT · ENGINEER

U.S. ARMY ENGINEER DIV. NEW ENGLAND
CORPS OF ENGINEERS
WALTHAM, MASS.

NATIONAL PROGRAM OF INSPECTION OF NON-FED. DAMS

LYNDE BROOK RESERVOIR DAM
SKETCH PLAN SHOWING LOCATION &
ORIENTATION OF PHOTOS

STATE - MA

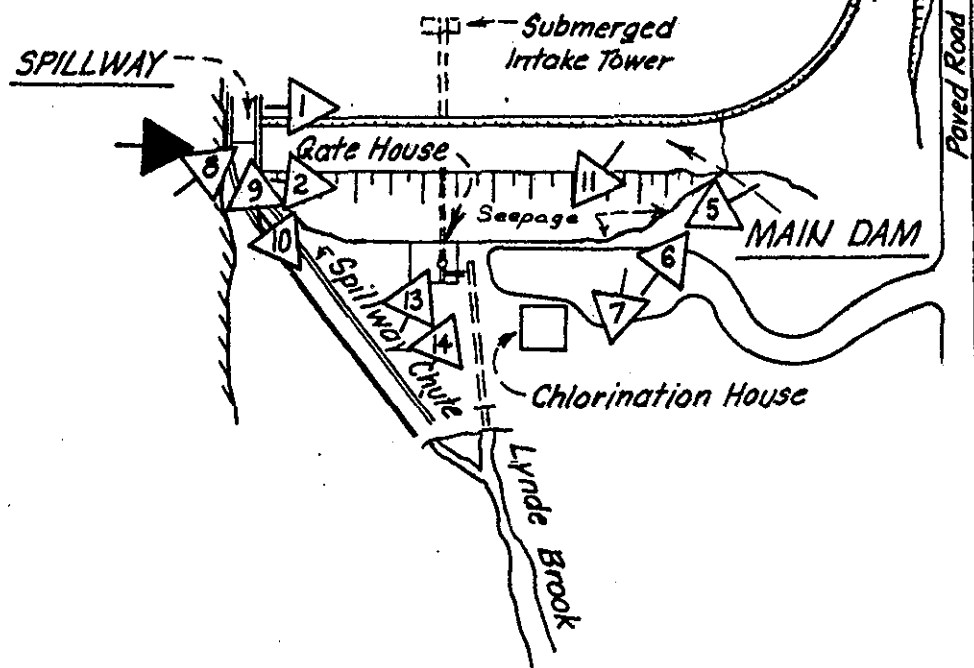
SCALE

DATE

OVERVIEW PHOTO
APPENDIX 'C' PHOTOS



LYNDE BROOK
RESERVOIR



LYNDE BROOK RESERVOIR DAM

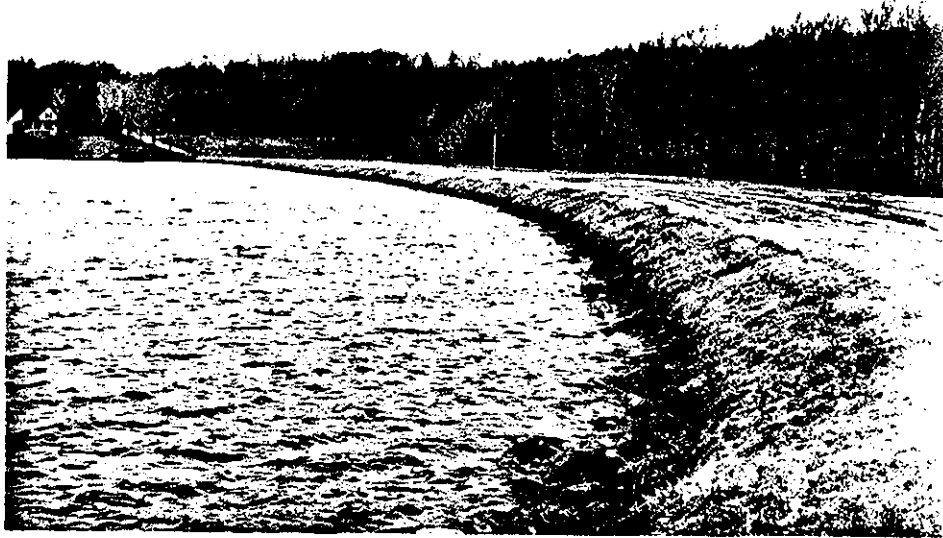


1. Upstream slope of dam



2. Downstream slope of dam

LYNDE BROOK RESERVOIR DAM



3. Upstream slope of East Dike



4. Downstream slope of East Dike

LYNDE BROOK RESERVOIR DAM



5. Seepage at downstream toe of dam



6. Seepage at junction of dam and left abutment of dam

LYNDE BROOK RESERVOIR DAM



7. Seepage on south side of roadway along downstream toe of dam.



8. View of spillway crest from right abutment.

LYNDE BROOK RESERVOIR DAM



9. Spillway training walls and angle iron sill



10. Downstream spillway channel

LYNDE BROOK RESERVOIR DAM

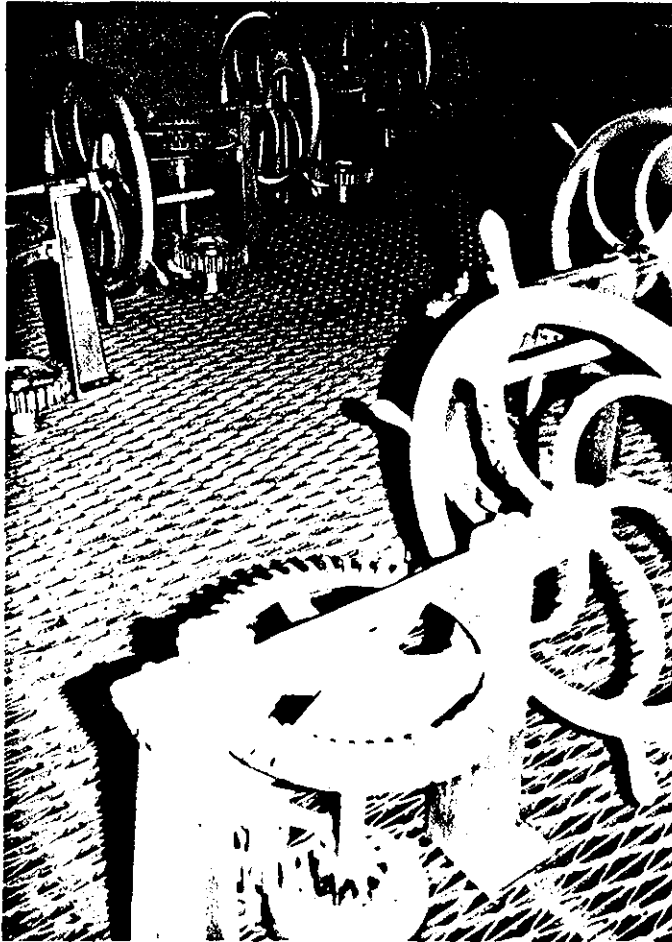


11. Outlet gate house on right and chlorination building on left at downstream toe of dam.



12. Gate house at northerly end of East Dike

LYNDE BROOK RESERVOIR DAM



13. Manual operating mechanisms in first floor of gate house at downstream toe of dam.



14. Outlet pipes, valves and stems in basement of gate house at downstream toe of dam.

APPENDIX D

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

BY RFB DATE 3-25-30 **LOUIS BERGER & ASSOCIATES INC.**
CHKD. BY _____ DATE _____ INSPECTION OF DAMS
SUBJECT LYNDE BROOK RESERVOIR

SHEET NO. 1 OF _____
PROJECT W-193

FIND DRAINAGE AREA

READ #2	32.10
" #1	<u>12.56</u>
	19.54

READ #3	51.65
" #2	<u>32.10</u>
	19.55

$$\text{DRAINAGE AREA} = 19.545 (0.1435) = \underline{2.80 \text{ SQ MI}} = \underline{1793 \text{ ACRES}}$$

RESERVOIR SURFACE AREA, ELEV. 834

READ #2	52.66
" #1	<u>51.29</u>
	1.37

READ #3	53.99
" #2	<u>52.66</u>
	1.33

$$\text{RES. AREA} = 1.35 \times 91.83 = \underline{124 \text{ ACRES}}$$

AREA @ ELEV. 830

READ #2	55.60
" #1	<u>53.99</u>
	1.61

READ #3	57.26
" #2	<u>55.60</u>
	1.66

$$\text{AREA @ ELEV. 830} = 1.635 (91.83) = \underline{150 \text{ ACRES}}$$

AREA @ ELEV. 840

READ #2	59.32
" #1	<u>57.26</u>
	2.06

READ #3	61.26
" #2	<u>59.32</u>
	2.04

$$\text{AREA @ ELEV. 840} = 2.05 (91.83) = \underline{188 \text{ ACRES}}$$

BY RFB DATE 4-29-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 1 OF 1
 CHKD. BY _____ DATE _____ INSPECTION OF DAMS PROJECT W-192
 SUBJECT LYNDE BROOK RESERVOIR DAM - STORAGE CAPACITY

RESERVOIR SURFACE AREA = 124 ACRES
 ASSUME $H = 824' - 769' = 55 \text{ FT}$

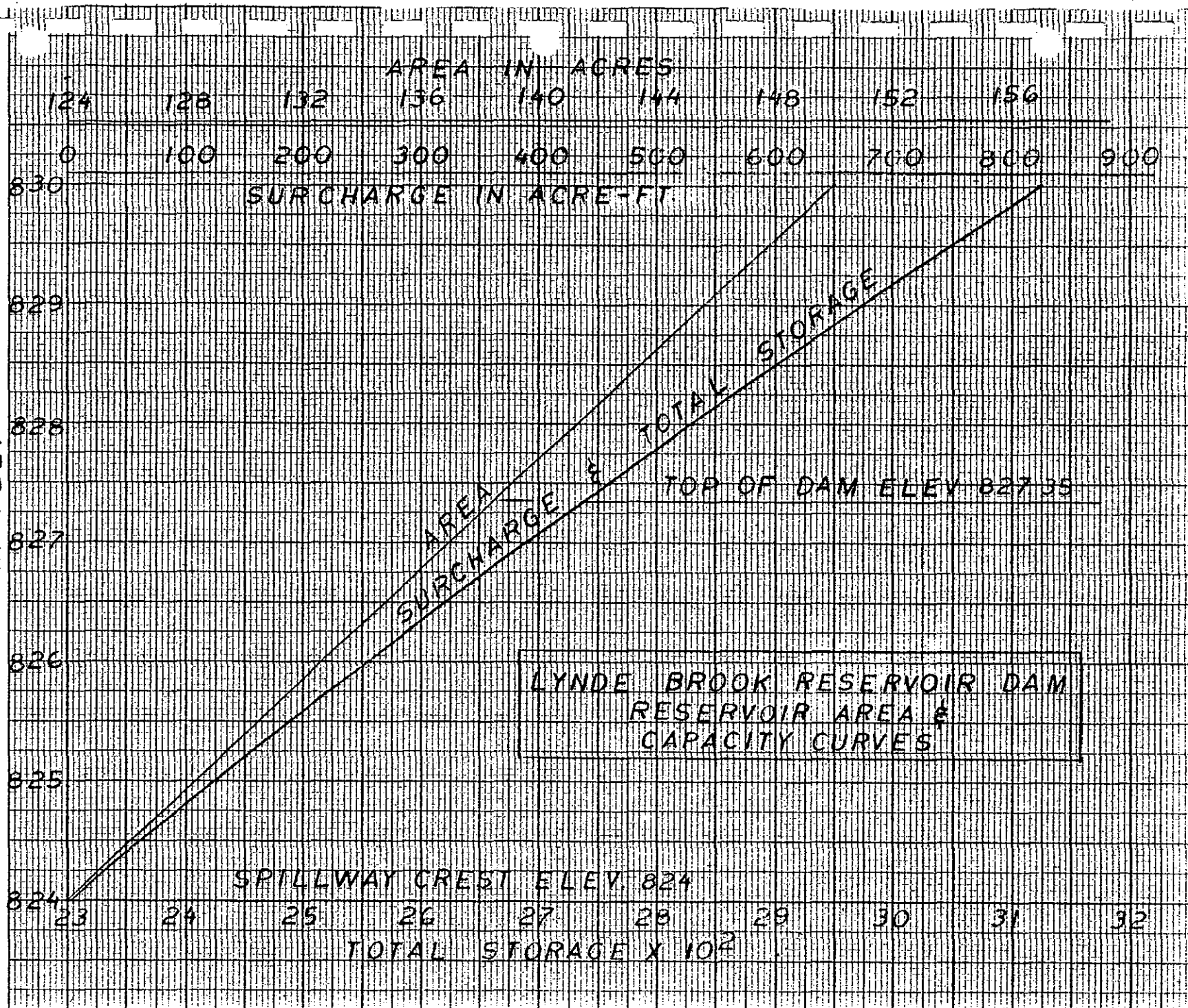
VOLUME AT ELEV 824 = $124 \times 55 \times \frac{1}{3} = 2273 \text{ ACRES-FT}$
 OLD INVENTORY SHEET: VOLUME = 2400 ACRES-FT

SAY NORMAL VOLUME = 2300 ACRES-FT

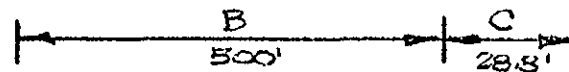
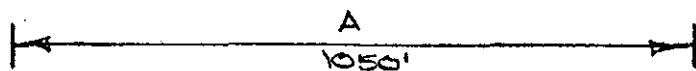
ELEV FT	AREA	AVE AREA	ΔH	Δ STORAGE	TOTAL STORAGE	SURCHARGE STORAGE
824	124				2300	0
825	128.3	126.15	1	126.1	2426	126
826	132.7	130.5	1	130.5	2557	257
827	137	134.85	1	134.8	2691	391
828	141.3	139.15	1	139.1	2830	530
829	145.7	143.5	1	143.5	2974	674
830	150	148.75	1	148.3	3123	823

6-0

ELEV IN FEET



BY REF. DATE 4-29-80 LOUIS BERGER & ASSOCIATES INC.
 CHKD. BY DATE INSPECTION OF DAM
 SUBJECT LYNDA HARRIS RESERVOIR DAM - BRANSON, MISSOURI
 SHEET NO. 1 OF 1
 PROJECT M-183



E = 827.35

E = 827.35

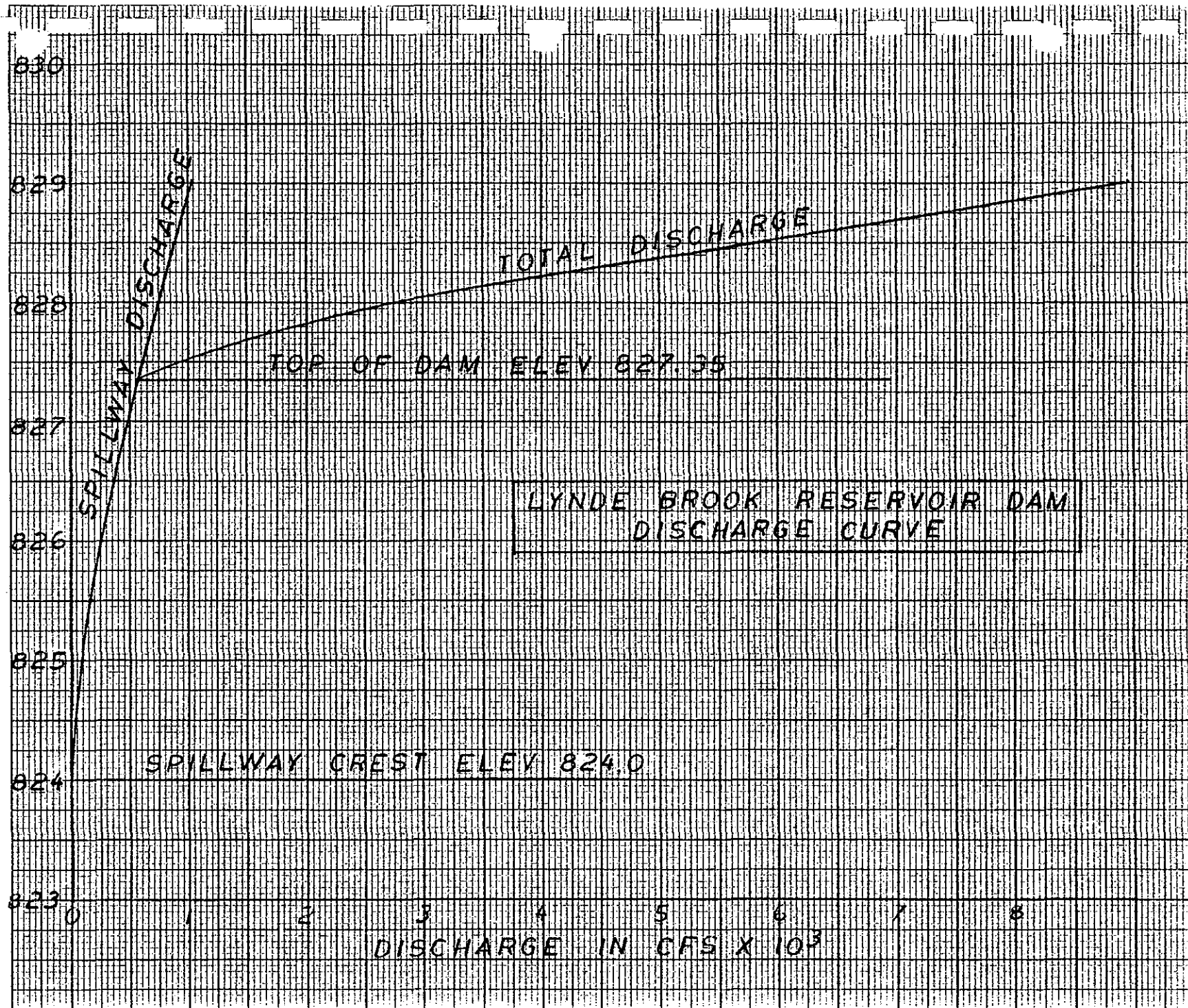
E = 824.0

ELEV. FT	A, C = 2.6			B, C = 2.6			C, C = 3.2			Σ Q
	H	L	Q	H	L	Q	H	L	Q	
824	0		0	0		0	0		0	0
824.5	0	1050	0	0	500	0	.5	28.8	33	30
825.5	0		0	0		0	1.5		169	170
826.5	0		0	0		0	2.5		364	360
827.35	0		0	0		0	3.35		565	560
828	.65		1431	.65		681	4		737	2850
828.5	1.15		3368	1.15		1603	4.5		880	5850
829	1.65		5786	1.65		2145	5		1030	8960
829.5	2.15			2.15			5.5			
830.0	2.65			2.65			6			

D-4

S-0 ELEV. IN FEET

KEUFFEL & ESSER CO.
MADE IN U.S.A.



DRAINAGE AREA (TOTAL) = 2.80 sq. mi
 RESERVOIR AREA < 25 % D.A.

LENGTH LONGEST WATER COURSE = L = 19,600 FT
 L = 3.71 MI

ELEV. DIFFERENCE = 1215 - 824 = 391 FT

$$\% \text{ SLOPE} = \frac{391}{3.71} = 105 \text{ FT/MI} \quad \sqrt{S} = 10.26$$

$$\left(\frac{LLC}{\sqrt{S}} \right)^{.33} = \left(\frac{3.71 \times 3.71}{10.26 \times 2} \right)^{.33} = 0.876$$

$$LAG = K \left(\frac{LLC}{\sqrt{S}} \right)^{.33} = 0.876 K$$

ASSUME K = 5.0 HRS REFER TO "CURVE E" MOUNTAINOUS REGION, MIXED TERRAIN, BOB RES

$$LAG = 0.876 K = 0.876 (5) = 4.38 \text{ HRS}$$

$$T_p = 0.41D + 0.32 LAG, \text{ WHERE } D = 1.0 \text{ HRS}$$

$$T_p = 0.41(1) + 0.32(4.38)$$

$$T_p = 0.41 + 3.57 = 4.0 \text{ HRS}$$

CHECK VELOCITY

$$T_c = \frac{T_p - 0.5D}{0.6}$$

$$T_c = \frac{4.0 - 0.5}{0.6} = 5.83 \text{ HRS}$$

$$V = \frac{19,600}{5.83 \times (3600)} = 0.93 \text{ FT/SEC} \quad \text{O.K.}$$

BY RFE DATE 4-4-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 2 OF 2
 CHKD. BY DATE INVESTIGATION OF DRAINAGE PROJECT W-122
 SUBJECT LYNDE E. BROWN RESERVOIR, W-122, INDIAN HILLS

$$T_R = 1.67 T_p = 1.67(4.0) = 6.68 \text{ HRS}$$

$$T_B = T_p + T_R = 4.0 + 6.68 = 10.68 \text{ HRS}$$

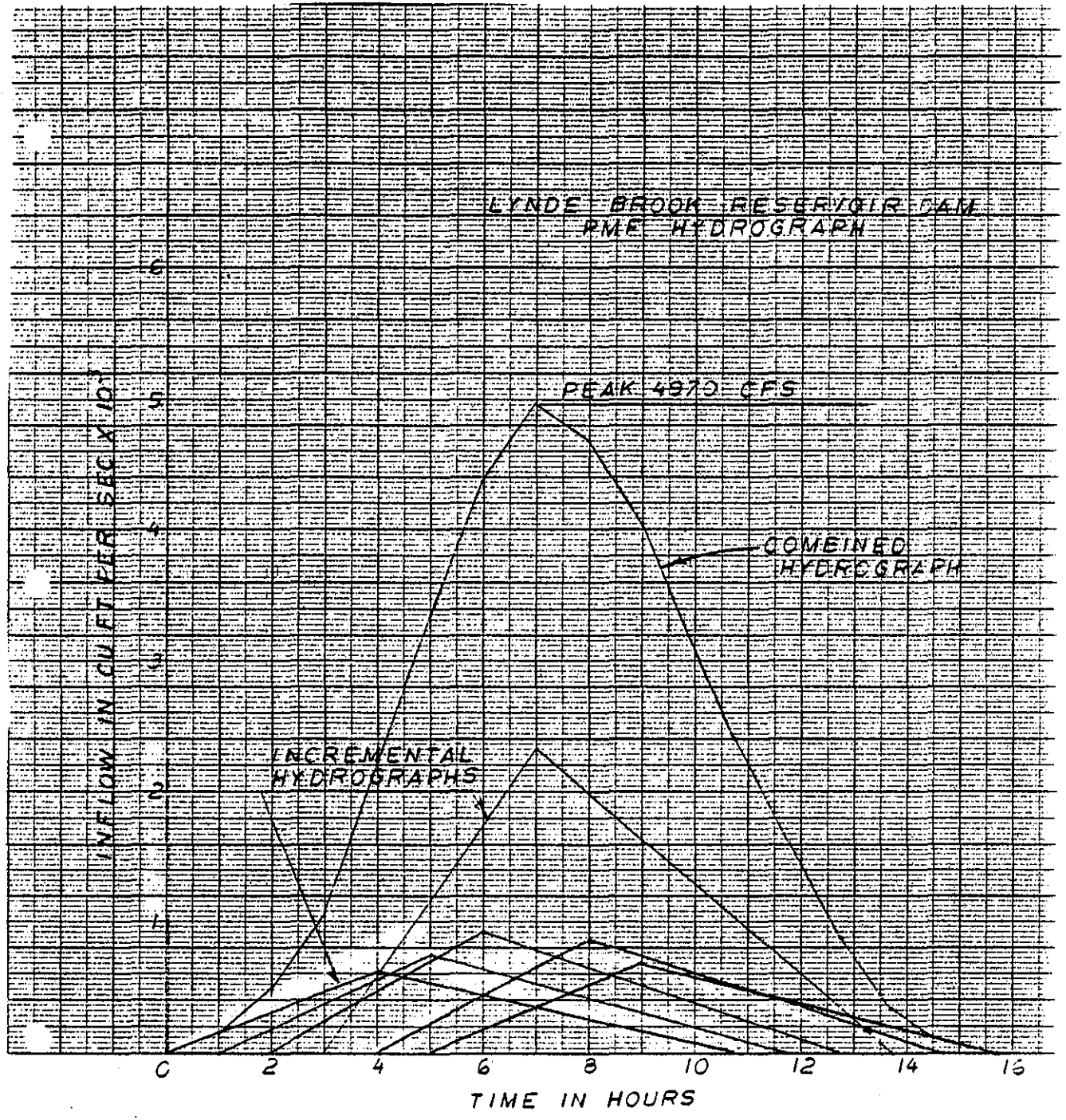
Q_p = PEAK RATE IN CFS

$$Q_p = \frac{434 A Q}{T_p} \quad \begin{array}{l} A = \text{DRAINAGE AREA} \\ Q = \text{RUNOFF IN INCHES} \end{array}$$

$$Q_p = \frac{434(2.80)(1)}{4.0} = 339 \text{ CFS}$$

PMP = PROBABLE MAXIMUM PRECIPITATION
 = 23" (0.8) = 18.4" FOR WORCESTER, MA.
 = 18" CONSIDERING INFILTRATION FOR OVERLAND FLOW

TIME (HOURS)	RAINFALL		Q CFS	TIME		
	%	INCHES		BEGIN	PEAK	END
0.0						
1.0	10	1.80	610	0	4.0	10.7
2.0	12	2.16	732	1.0	5.0	11.7
3.0	15	2.70	915	2.0	6.0	12.7
4.0	38	6.34	2218	3.0	7.0	13.7
5.0	14	2.52	834	4.0	8.0	14.7
6.0	11	1.98	671	5.0	9.0	15.7



BY REB DATE 5-1-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 1 OF 3
CHKD. BY DATE INSPECTION OF DAMS PROJECT W-100
SUBJECT LYNDS BROOK RESERVOIR DAM, RESERVOIR ROUTING

DRAINAGE AREA = 2.80 sq. mi = 1795 Acres

MAXIMUM STORAGE = 2737 Acres

HEIGHT TO STREAMBED = 327.33 - 76.97 = 58 ft

SIZE CLASSIFICATION: INTERMEDIATE

HAZARD CLASSIFICATION = HIGH
OCE GUIDELINES, USE PMF

FROM INFLOW HYDROGRAPH, PMF = 4,970 cfs

STEP 1: $Q_{p1} = 4970$

STEP 2a: ELEV. = 828.37

STEP 2b: SURCHARGE VOLUME = 580 Acre-ft

$$\text{INCHS OF RUNOFF} = \frac{580 \text{ Acre-ft}}{1795 \text{ Acres}} \times \frac{12 \text{ in}}{\text{ft}} = 3.88 \text{ in.}$$

STEP 2c:

$$Q_{p2} = 4970 \times \left(1 - \frac{3.88}{19}\right) \\ = 3955 \text{ cfs}$$

STEP 3a: For $Q = 3955$

SURCHARGE HEIGHT = 828.21 ft

SURCHARGE VOLUME = 560 Acre-ft

BY RFB DATE 5-1-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 2 OF 3
 CHKD. BY _____ DATE _____ INSPECTION OF DAM PROJECT W-148
 SUBJECT LYNDE BROOK RESERVOIR DAM, RESERVOIR ROUTING

$$\text{INCHS OF RUNOFF} = \frac{560}{1795} \times 12 \text{ IN/FT} = 3.74 \text{ INCHS}$$

STEP 3b

$$\text{AVE STORAGE} = \frac{3.88 + 3.74}{2} = 3.81$$

$$\text{AVE. SURCHARGE} = \frac{3.81 \times 1795}{12 \text{ IN/FT}} = 570 \text{ ACRES-FT}$$

FROM STAGE STORAGE CURVE \therefore STAGE = 828.28

FROM STAGE-DISCHARGE CURVE \therefore $Q_p = 4,350$

PMF OVERTOPS DAM & DIKE BY $828.28 - 827.35 = 0.93 \text{ FT}$
 $Q_p = 4,350 \text{ CFS}$

TRY $\frac{1}{2}$ PMF = 2485 CFS

STEP 1: $Q_{p1} = 2485 \text{ CFS}$

STEP 2a: SURCHARGE HEIGHT = 827.95

STEP 2b: SURCHARGE VOLUME = 522 ACRES-FT

$$\text{INCHS OF RUNOFF} = \frac{522 \text{ ACRES-FT}}{1795 \text{ ACRES}} \times 12 \text{ IN/FT} = 3.49 \text{ IN.}$$

STEP 2c: $Q_{p2} = 2485 \left(1 - \frac{3.49}{9.5}\right) =$

$$Q_{p2} = 1572 \text{ CFS}$$

BY RFB DATE 5-1-80 LOUIS BERGER & ASSOCIATES INC. SHEET NO. 3 OF 3
CHKD. BY DATE INSPECTION OF DAMS PROJECT W-192
SUBJECT LYNDE CREEK RESERVOIR DAM, RESERVOIR ROUTING

STEP 3a: FOR $Q = 1,572$ CFS

SURCHARGE HEIGHT = 827.75

SURCHARGE VOLUME = 495 ACRE-FT

INCHS OF RUNOFF = $\frac{495}{1795} \times 12 \text{ IN/IN} = 3.21 \text{ IN}$

STEP 3b AVE STORAGE $\frac{3.49 + 3.21}{2} = 3.4 \text{ INCHS}$

AVE SURCHARGE = $\frac{3.4 \times 1795}{12 \text{ IN/HR}} = 508 \text{ ACRE-FT}$

FROM STAGE STORAGE CURVE Δ STAGE = 827.25

FROM STAGE DISCHARGE CURVE Δ $Q_{P3} = 2,100$ CFS

$\frac{1}{2}$ PMF OVERTOPS DAM & DIKE BY $827.85 - 827.35 = 0.50'$
 $Q_{P3} = 2,100$ CFS

BY RF3 DATE 5-1-80 LOUIS BERGER & ASSOCIATES INC. SHEET NO. 1 OF 7
CHKD. BY DATE INSPECTION OF DAMS PROJECT W-195
SUBJECT LYNDE BROOK RESERVOIR DAM - FAILURE ANALYSIS

STEP 1: RESERVOIR ELEV @ FAILURE = 827.35
WATER AT TOP OF DAM
STORAGE = 2737 ACRE-FT

HEIGHT ABOVE BENCH AT TOE OF MAIN DAM =
= 827.35 - 796.3 = 31 FT

ASSUME FAILURE HEIGHT TO BENCH AT TOE = $H = 31$ FT

STORAGE ABOVE ELEVATION 796.3 =

$$S = 2737 - \frac{1}{3} (26.7) \frac{26.7}{33} (124)$$

$$S = 2737 - 536 = 2200 \text{ ACRE-FT}$$

$$\text{LENGTH} = 500 \text{ FT}$$

STEP 2: PEAK FAILURE OUTFLOW

$$Q_{p1} = 8/27 W \sqrt{g} Y_0^{3/2}$$

$$W = 38\% L = 38\% \text{ OF } 500 = 190 \text{ FT}$$

$$Y_0 = 31 \text{ FT}$$

$$Q_{p1} = 1.68 (190) (31)^{3/2}$$

$$Q_{p1} = 55,094$$

$$\text{ADD SPILLWAY } Q = 565 \text{ CFS}$$

$$Q_{p1} \text{ TOTAL} = 55,094 + 565 = 55,659$$

$$\text{SAY } Q_{p1} = 55,000 \text{ CFS}$$

STA 0+00 TO STA 28+00

$$n = .08$$

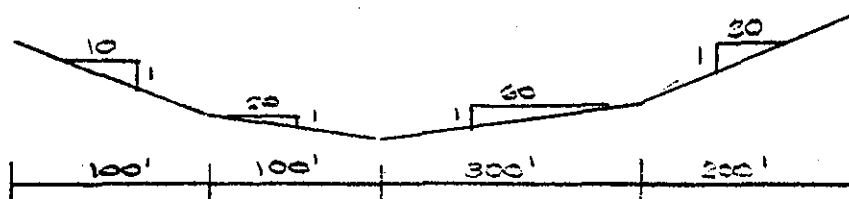
$$Q = \frac{1.486}{n} R^{2/3} S^{1/2}$$

$$Q = 2.82 A R^{2/3} S^{1/2}$$

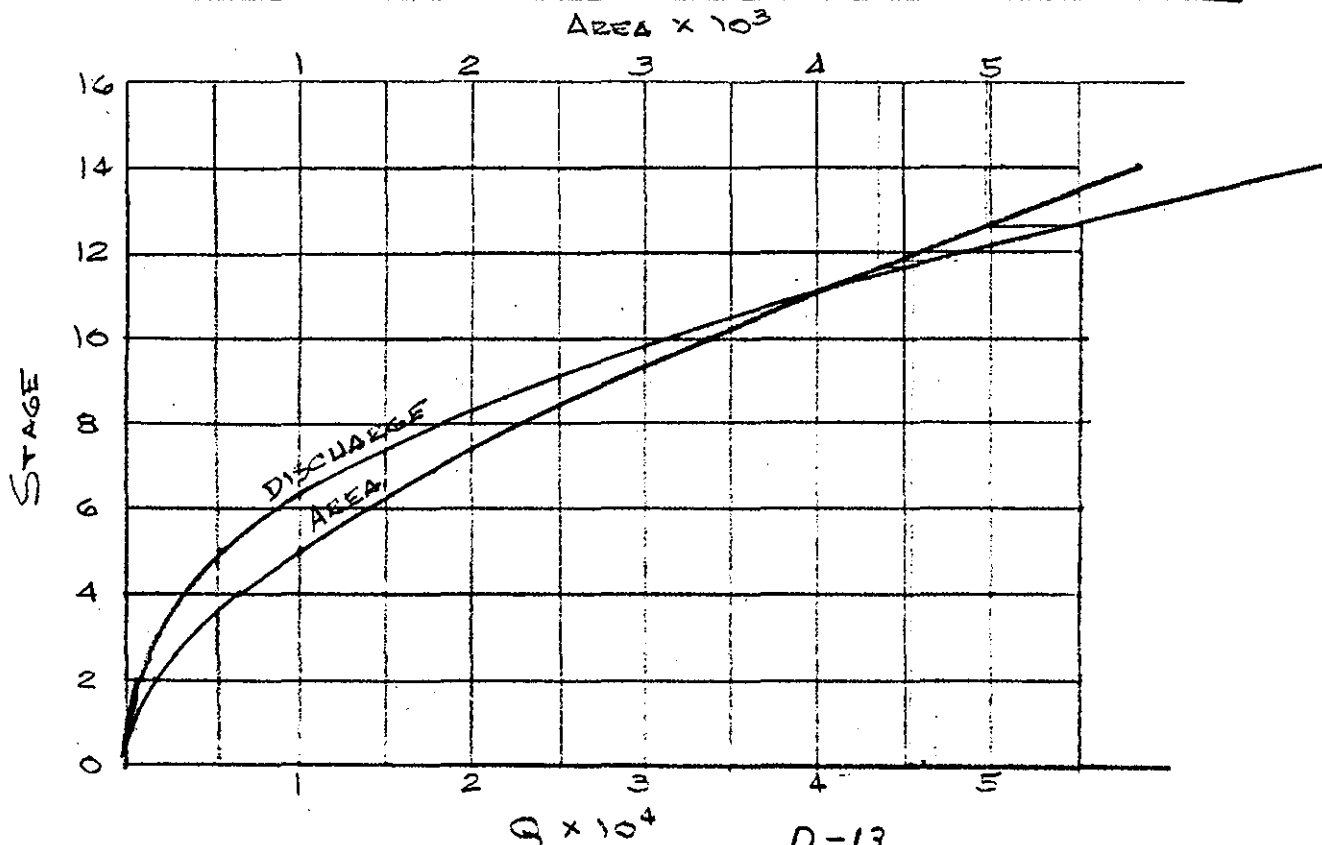
$$S = \frac{750 - 672}{2500}$$

$$S = \frac{78}{2500} = .0232$$

$$S^{1/2} = 0.152$$



STAGE	A	P	R	$R^{2/3}$	Q
2	160	160.1	1.0	1.0	451
5	1000	400.2	2.5	1.84	5184
10	3375	550.6	6.1	3.35	31890
14	5815	670.8	8.7	4.22	64200



FOR $Q = 55,000$, STAGE = 13.7, AREA = 4980

$$V_1 = \frac{4980 \times 2800}{43,560} = 320 \text{ ACRES-FT}$$

$$Q_{P2} (\text{TRIAL}) = 55,000 \left(1 - \frac{320}{2200}\right)$$

$$Q_{P2} (\text{TRIAL}) = 47,000$$

FOR $Q = 47,000$, STAGE = 11.8, $A = 4500$

$$V_2 = \frac{4500 \times 2800}{43,560} = 289 \text{ ACRES-FT}$$

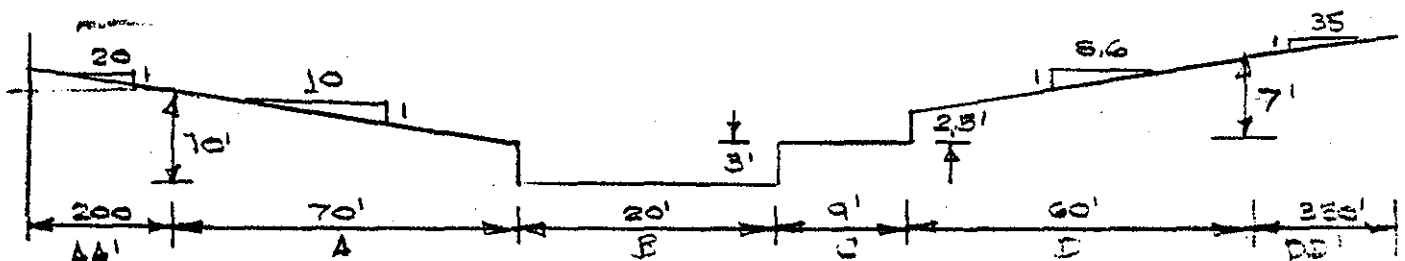
$$V_{AVE} = 304 \text{ ACRES-FT}$$

$$Q_{P2} = 55,000 \left(1 - \frac{304}{2200}\right)$$

$$= 47,400$$

STA 28+00, $Q = 47,400$, STAGE = 11.9, $\Delta H = 9.5 \text{ FT}$

STA 28+00 TO STA 25+00
 (OUTLET TO SMITHS POND)



OUTLET STRUCTURE
 SMITHS POND

D-14

SMITH POND OUTLET

STAGE	A, C=2.6			B, C=3.1			C, C=3.1			D, C=2.5		
FT	H	L	Q	H	L	Q	H	L	Q	H	L	Q
1.5	0	0	0	1.5	20	114	0	9	0	0	0	0
3.0	0	0	0	3		322	0		0	0	0	0
4.0	.5	5	5	4		496	1		28	0	0	0
5.5	1.25	13	47	5.5		800	2.5		110	0	0	0
6.5	1.75	18	108	6.5		1027	3.5		182	.5	9	8
7.5	2.25	23	202	7.5		1273	4.5		266	1	17	42
9	3	60	810	9		1674	6		410	1.75	30	177
10	3.5	70	1192	10		1960	7		516	2.25	39	330
15	8.5	70	4510	15	20	3602	12	4	1160	7.5	60	3080
20	13.5	70	9027	20	20	5545	17	9	1955	12.25	60	6421

D-15

STAGE	AA', C=2.3			BB', C=2.3			Σ
FT	H	L	Q	H	L	Q	Q
1.5	0			1.5			110
3.0							320
4.0							500
5.5							850
6.5							1140
7.5							1520
9							2661
10							3482
15	2.5	100	909	2.5	175	1542	14853
20	5	200	5143	5	175	4500	32,403

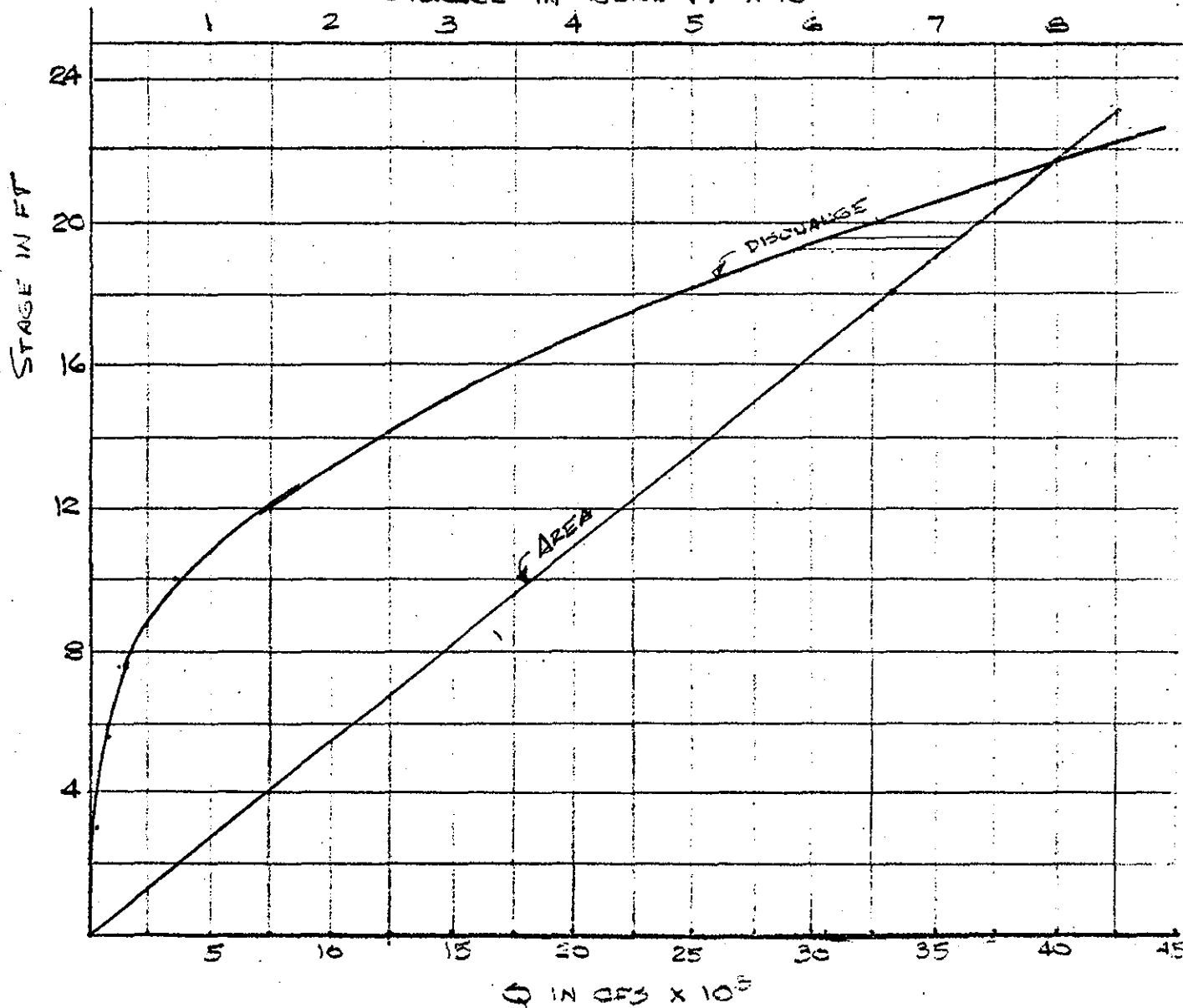
BY RFE DATE 5-6-80 LOUIS BERGER & ASSOCIATES INC.
 CHKD. BY DATE INSPECTION OF
 SUBJECT LYNDY CREEK RESERVOIR DAM & FOREBAY ANALYSIS
 SHEET NO. 4 OF 7
 PROJECT W-153

BY RER DATE 5-6-80 LOUIS BERGER & ASSOCIATES INC. SHEET NO. 5 OF 7
 CHKD. BY _____ DATE _____ INSPECTION OF DAMS PROJECT W-198
 SUBJECT LYNDE BROOK RESERVOIR DAM, FAILURE ANALYSIS

SURCHARGE STORAGE IN SMITH POND

$$V = (0.40)(91.83)(12) = 662 \text{ ACRE-FT}$$

STORAGE IN ACRE-FT $\times 10^2$



REACH #2

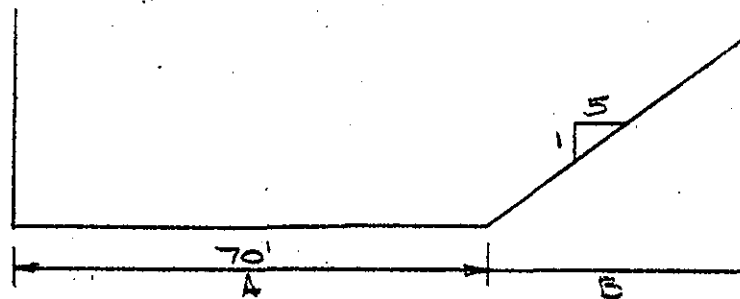
$$Q_{P2}(\text{TRIAL}) = 47,400 \left(1 - \frac{849}{2200} \right) = 29,300 \text{ CFS}$$

For $Q = 29,300$ $V_2 = 703$ $V_{AVE} = 772$

$$Q_{P2} = 47,400 \left(1 - \frac{772}{2200} \right) = 30,600 \text{ CFS}$$

STA 38+00, $Q = 30,600$, $H = 19.5$, $\Delta H \approx 15 \text{ FT}$

STA 38+00 TO STA 62+00, $L = 2400 \text{ FT}$



DAM @ SECOND MILL DOWNSTREAM

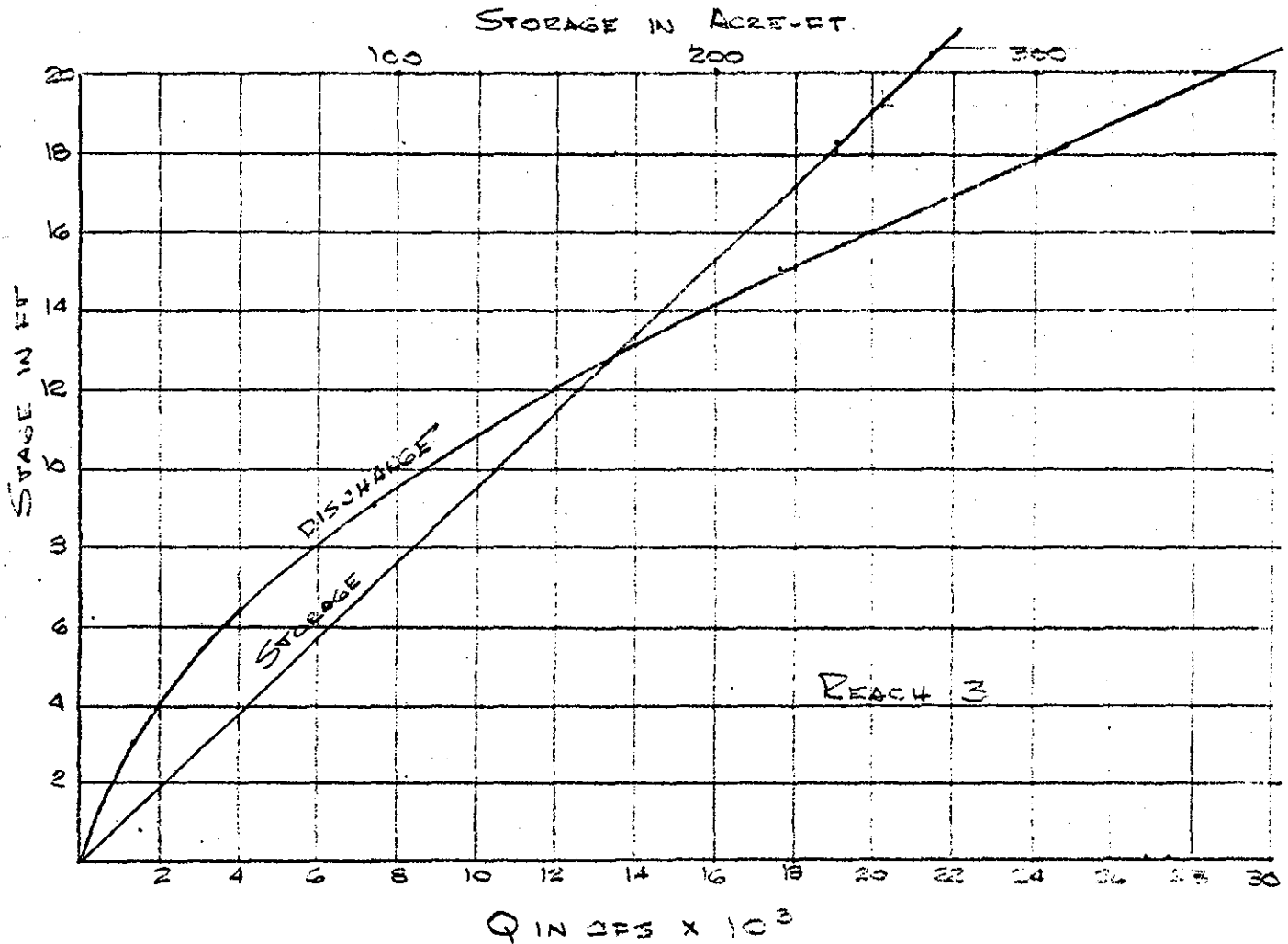
STAGE	A, C=3.2			B, C=3.0			ΣQ
FT	H	L	Q	H	L	Q	
3	3	70	1160	1.5	15	82	1240
6	6	70	3292	3	30	468	3760
9	9		6050	4.5	45	1283	7340
12	12		9311	6	60	2645	11960
15	15		13013	7.5	75	4620	17633
18	18		17106	9	90	7290	24,900

Area @ ELEV 18 = $18 \times 70 + (18 \times 90) \frac{1}{2} = 2070$

SAY CROSS SECTIONAL AREA IS TWICE AS GREAT FOR STORAGE PURPOSES

$$V = \frac{4140 \times 2400}{43,560} \approx 230 \text{ ACRE-FT}$$

BY RFB DATE 5-6-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 7 OF 7
 CHKD. BY _____ DATE _____ INSPECTION OF DAMS PROJECT W-198
 SUBJECT LYNDE SOUTH RESERVOIR DAM, FAILURE ANALYSIS



$$Q_{P2} (\text{TRIAL}) = 30,600 \left(1 - \frac{270}{2200} \right) = 26,850$$

$$\text{FOR } Q = 26,850, \quad V_2 = 250 \quad V_{\text{AVE}} = 260$$

$$Q_{P2} = 30,600 \left(1 - \frac{260}{2200} \right) = 27,000$$

$$\text{STA } 62+00, \quad Q = 27,000, \quad H = 19, \quad \Delta H = 17 \text{ FT}$$

BY RFE DATE 3-2-80 LOUIS BERGER & ASSOCIATES INC. SHEET NO. 1 OF 1
 CHKD. BY DATE INSPECTION OF DAM PROJECT W-138
 SUBJECT LYNDE EBOOK RESERVOIR DAM, LOW LEVEL - OUT RT

ASSUME PIPE LENGTH = 450 FT. LONG

ΣK = ENTRANCE LOSS + EXIT LOSS + FRICTION LOSS

$$\Sigma K = 0.5 + 1.3 + \left(\frac{8L}{D} = \frac{.028 \times 450}{2} \right) = 7.4$$

$$Q = A \sqrt{\frac{2gh}{\Sigma K}}$$

@ NORMAL POOL ELEV.: $h = (824 - 796.3) - 12 = 39.7'$

$$Q = \frac{\pi 2^2}{4} \sqrt{\frac{2g(39.7)}{7.4}} = 58.4 \text{ SAY } 58 \text{ CFS}$$

@ TOP OF DAM : $h = (827.25 - 796.3) - 12 = 43.05'$

$$Q = \pi \sqrt{\frac{2g(43.05)}{7.4}} = 60.7 \text{ SAY } 61 \text{ CFS}$$

BY RF3 DATE 7-22-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 1 OF 2
 CHKD. BY DATE INSPECTION OF DAM PROJECT W-103
 SUBJECT LYNCH POND RESERVOIR, DIKE FAILURE ANALYSIS

STEP 1: RESERVOIR ELEVATION @ FAILURE = 827.35
 WATER @ TOP OF DIKE

ASSUME FAILURE HEIGHT TO TOE OF DIKE $H = 14.3$ FT

STORAGE ABOVE TOES:

$$\Delta V = 2737 - 2300 + \frac{1}{3}(H)(b_1 + b_2 + \sqrt{b_1 b_2})$$

$$\Delta V = 437 + \frac{1}{3}(96)(102 + 124 + \sqrt{102 \times 124})$$

$$\Delta V = 437 + 1083 = 1520$$

SAY 1520 A.F.

HEIGHT OF DIKE = 14.3 FT

LENGTH OF DAM @ MID-HEIGHT = $1030 - 400 = 650$ FT.

$$W = 20\% \text{ OF } 650 \text{ FT} = 130 \text{ FT.}$$

STEP 2: PEAK FAILURE OUTFLOW

$$Q_{PI} = 8/27 W \sqrt{g} Y_0^{3/2}$$

$$Q_{PI} = 1.68 (130)(14.3)^{3/2}$$

$$Q_{PI} = 11,800 \text{ CFS}$$

NO SPILLWAY DISCHARGE

BY RFB DATE 7-22-80 LOUIS BERGER & ASSOCIATES INC. SHEET NO. 2 OF 6
 CHKD. BY _____ DATE _____ INSPECTION OF 2400 PROJECT W-199
 SUBJECT LYNDE 3300K RESERVOIR, DICE FILLING ANALYSIS

REACH 1 - FROM DICE TO CLOSED END OF
 JUST ABOVE ROUTE 2
 L = 7000 FT

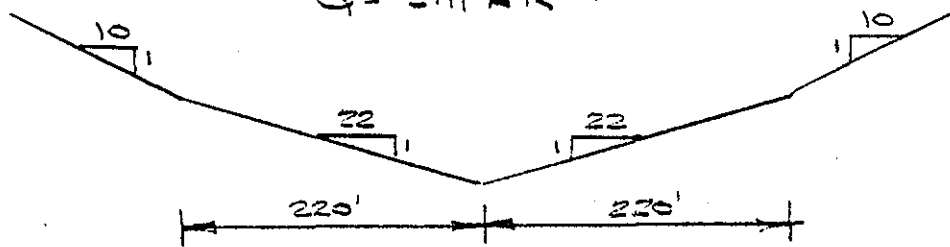
$$Q = \frac{1.486}{n} AR^{2/3} S^{1/2}$$

$$Q = 2.11 AR^{2/3}$$

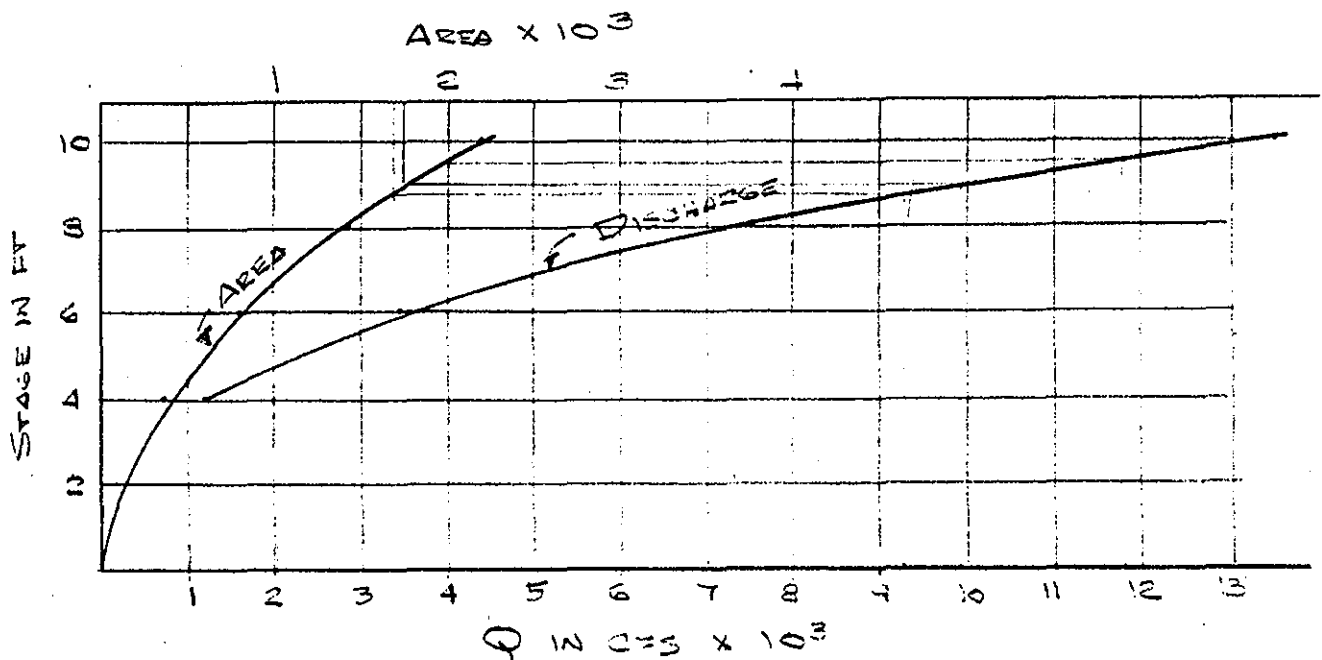
$$S = \frac{810 - 640}{7000} = .0243$$

$$S^{1/2} = 0.156$$

$$n = .110$$



STAGE	AREA	P	$R^{2/3}$	Q
4	352	176.2	1.59	1180
6	792	264.3	2.08	3176
8	1408	352.4	2.52	7490
10	2200	440.5	2.92	13560
12	3120	480.7	3.48	22910



D-21

For $Q = 11,800$ STAGE = 9.5 FT, AREA = 2000 I

$$V_1 = \frac{7000 \times 2000}{43,560} = 322 \text{ A.F.}$$

$$Q_{P2} (\text{TRIAL}) = 11,800 \left(1 - \frac{322}{1500}\right)$$

$$" " = 9,270 \text{ CFS}$$

For 9,270, STAGE = 8.8 FT, AREA = 1700 II

$$V_2 = \frac{7000 \times 1700}{43,560} = 273 \text{ A.F.}$$

$$V_{AVE} = \frac{322 + 273}{2} = 298 \text{ A.F.}$$

$$Q_{P2} = 11,800 \left(1 - \frac{298}{1500}\right) = 9,450 \text{ CFS}$$

STAGE @ 9 FT, , 4 HOMES FLOODED 2 TO 6 FT
(CHERRY VALLEY)

STREAM NOW GOES INTO A CLOSED CONDUIT
WHICH IS BELIEVED TO GO TO CURTIS POND

TWIN CONDUIT 2.5 FT HIGH X 5 FT WIDE

$$\text{ASSUME HEAD ON CONDUIT HW} = 2.5 + 3 + 9 = 14.5$$

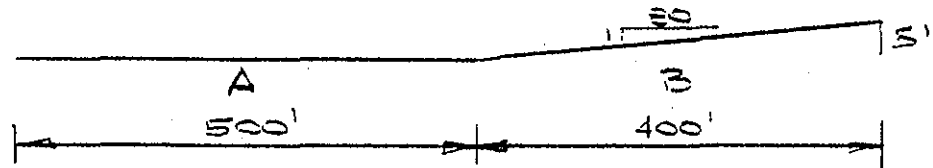
$$HW/D = 5.8, \quad Q/B = 45, \quad Q = 450$$

$$\text{MAX CAPACITY OF CONDUIT} = 450 \text{ CFS}$$

THEREFORE 9,000 CFS FLOWS ACROSS R+R

BY REB DATE 7-22-80 LOUIS BERGER & ASSOCIATES INC. SHEET NO. 4 OF 6
 CHKD. BY INSPECTION DATE 7-22-80 PROJECT LYNDE BROS. REDEV. OF 50 A.F.
 SUBJECT LYNDE BROS. REDEV. OF 50 A.F.

Rt 9 CROSSING

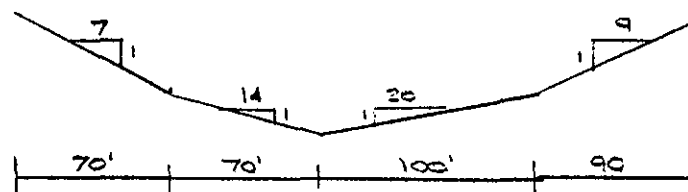


ASSUME WEIR FLOW

STAGE	C=2.6			C=2.6			ΣQ
	H	L	Q	H	L	Q	
1	1	500	1300	.5	80	75	1320
2	2		3680	1.0	160	420	4100
3	3		6750	1.5	240	1150	7900
4	4		10400	2	320	2356	12750

DEPTH OF FLOW ACROSS RT 9 = 3.5 FT
 ΔVE 50 A.F.

SECTION IN RESIDENTIAL AREA SOUTH OF RT 9.

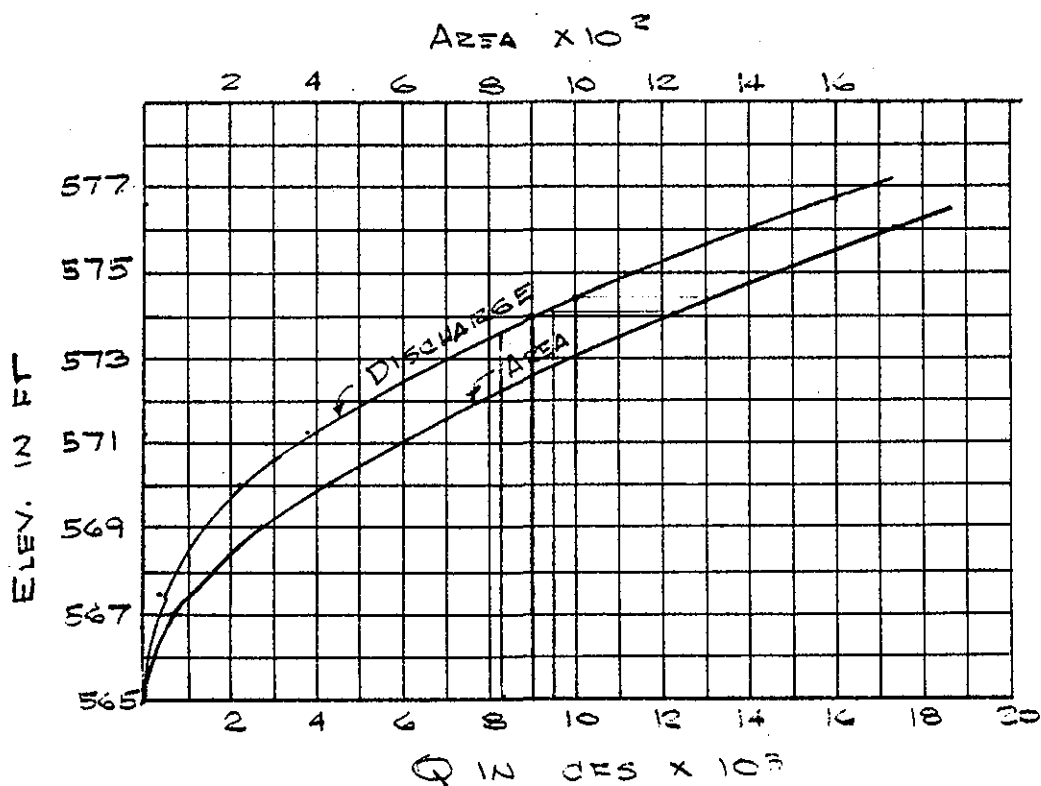


BY: RFB DATE: 7-23-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 5 OF 6
 CHKD. BY: _____ DATE: _____ INSPECTION OF DAM PROJECT W-198
 SUBJECT: LYNDE BROOK RESERVOIR, DIKE FAILURE

ASSUME CRITICAL FLOW

$$Q_c = \sqrt{\frac{A^3 g}{T}}$$

ELEV	DEPTH	TOP WIDTH	AREA	Q_c	V_c	h_{vc}	$d+h_{vc}$	W.S. ELEV.
565	0	0	—	—	—	—	—	565
567	2	68	68	386	5.67	0.5	2.5	567.5
569	4	136	272	2183	8.03	1.0	5.0	570.0
570	5	170	425	3513	9.97	1.2	6.2	571.2
572	7	202	797	8483	11.27	2.0	9.0	574
574	9	234	1233	16060	13.02	2.6	11.6	576.6
576	11	266	1733					



BY REF DATE 7-23-80 **LOUIS BERGER & ASSOCIATES INC.** SHEET NO. 6 OF 6
 CHKD. BY DATE INSPECTION OF DMS PROJECT 11-105
 SUBJECT LYNDS BROWN ROAD, DINE FLOOD

For $Q = 9,450$ CFS, $W.A.E. = 9.1$, $AREA = 1220$

SAY AREA FOR VOLUME PURPOSES = $3 \times AREA$

$$V_1 = \frac{1500 \times 3 \times 1220}{43,500} = 126 \text{ A.F.}$$

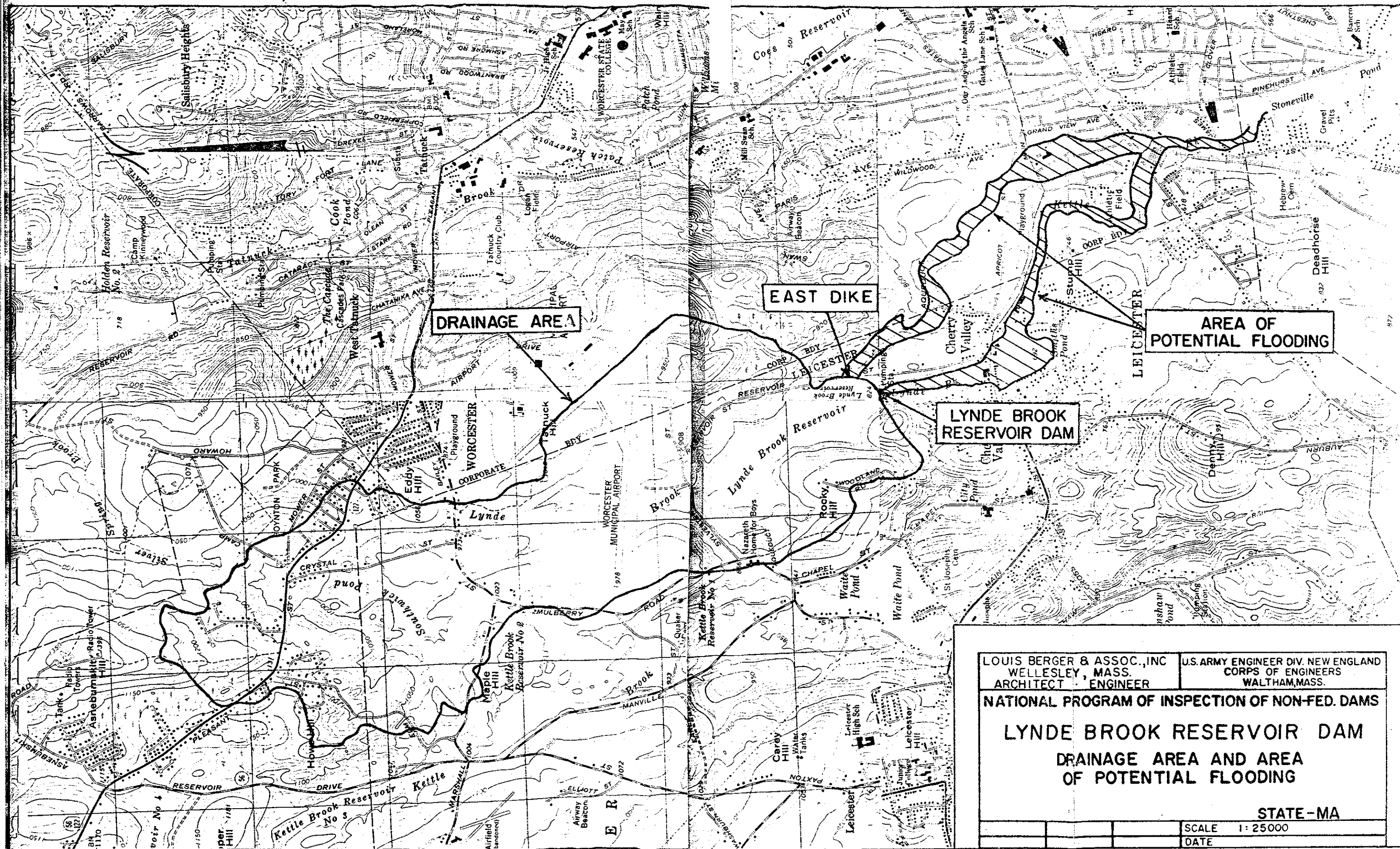
ADD VOLUME NORTH OF ROUTE 9 $\Delta V = 30 \text{ A.F.}$

$$Q_{P2} (\text{TRIAL}) = 9,450 \left(1 - \frac{126 + 30}{1500} \right)$$

$$" " = 8340 \text{ CFS}$$

$$H = 573.6 - 565 = 8.6 \text{ FT}$$

50-70 HOMES FLOODED	1-9 FT
6 COMMERCIAL	1-4 FT
1 SCHOOL	3 FT
1 CHURCH	3 FT



APPENDIX E

INFORMATION AS CONTAINED
IN THE
NATIONAL INVENTORY OF DAMS



INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR. DIST.	STATE	COUNTY	CONGR. DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE DAY MO YR
MA	990	NED	MA	027	03				LYNDE BROOK RESERVOIR DAM	4215.1	7152.4	0000080

POPULAR NAME	NAME OF IMPOUNDMENT
	LYNDE BROOK RESERVOIR

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	09	LYNDE BROOK	LEICESTER	0	9100

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCT. HEIGHT (FT.)	HYDRAU. HEIGHT (FT.)	IMPOUNDING CAPACITIES	
					MAXIMUM (ACRE-FT.)	NORMAL (ACRE-FT.)
REPG	1876	S	59	59	2737	2300

DIST OWN FED R PRV/FED SCS A VER/DATE
NED N N N N 16APR80

REMARKS

D/S HAS	SPILLWAY			MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY		NAVIGATION LOCKS									
	CHEN LENGTH	TYPE	WIDTH (FT.)			INSTALLED (MW)	PROPOSED (MW)	NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)			
1	530	U	29	560	76500												

OWNER	ENGINEERING BY	CONSTRUCTION BY
CITY OF WORCESTER, MA	WM. J. MCALPINE	

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

INSPECTION BY	INSPECTION DATE DAY MO YR	AUTHORITY FOR INSPECTION
LOUIS BERGER & ASSOC INC	16APR80	PL92-367

REMARKS



INVENTORY OF DAMS IN THE UNITED STATES

STATE	IDENTITY NUMBER	DIVISION	STATE	COUNTY	CONGR DIST.	STATE	COUNTY	CONGR DIST.	NAME	LATITUDE (NORTH)	LONGITUDE (WEST)	REPORT DATE
MA	1200	NED	MA	027	03				LYNDE BROOK RESERVOIR DIKE	4215.1	7152.4	16APR80

POPULAR NAME	NAME OF IMPOUNDMENT
	LYNDE BROOK RESERVOIR

REGION	BASIN	RIVER OR STREAM	NEAREST DOWNSTREAM CITY-TOWN-VILLAGE	DIST FROM DAM (MI.)	POPULATION
01	09	TR-KETTLE BROOK	LEICESTER	0	9100

TYPE OF DAM	YEAR COMPLETED	PURPOSES	STRUCTURAL HEIGHT (FT.)	HYDRAULIC HEIGHT (FT.)	IMPOUNDING CAPACITIES	
					MAXIMUM (ACRE-FT.)	NORMAL (ACRE-FT.)
REPG	1876	S	14	14	1520	1080

DIST OWN FED R PRV/FED SCS A VER/DATE
NED N N N N 16APR80

REMARKS

D/S HAS	SPILLWAY			MAXIMUM DISCHARGE (FT.)	VOLUME OF DAM (CY)	POWER CAPACITY		NAVIGATION LOCKS									
	CREST LENGTH	TYPE	WIDTH (FT.)			INSTALLED (MW)	PROPOSED (MW)	NO.	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)	LENGTH (FT.)	WIDTH (FT.)			
1	1050	N			18000												

OWNER	ENGINEERING BY	CONSTRUCTION BY
CITY OF WORCESTER, MA		

REGULATORY AGENCY			
DESIGN	CONSTRUCTION	OPERATION	MAINTENANCE
NONE	NONE	NONE	NONE

INSPECTION BY	INSPECTION DATE	AUTHORITY FOR INSPECTION
LOUIS BERGER + ASSOC INC	16APR80	PL92-367

REMARKS
31-SPILLWAY AT DAM MA00990